VOL. XVII.
No. CCCCVIII.] SEPTEMBER 19, 1885. [PRICE, FOURPENCE.

29 1885
COLLEGE

THE ELECTRICAL REVIEW

LONDON: PUBLISHING OFFICE, 22, PATERNOSTER ROW, E.C.—Subscription per annum, Postage inclusive, in Great Britain, 19s. 6d.; to Countries in Postal Union, of the first class, 21s. 6d.; of the second class (Aden, India, Persia, &c.), 23s. 10d.—New York: D. Van Nostrand, 23, Murray Street, and 27, Warren Street. Paris: Madame Veuve J. Boyveau, Librairie Etrangère, 22, Rue de la Banque. Berlin: A. Asher & Co., 5, Unter den Linden.

JOHNSON & PHILLIPS,
TELEGRAPH ENGINEERS, ELECTRICIANS AND CONTRACTORS.

OFFICES:—14, UNION COURT, OLD BROAD STREET, LONDON, E.C. WORKS:—CHARLTON, KENT.

TELEGRAPHIC ADDRESS:—"JUNO" LONDON.

UNITED EXCHANGE TELEPHONE No. 1,010. PRIVATE WIRE, CITY OFFICES TO WORKS.

Manufacturers of all Telegraph Appliances, Materials, and Machinery for Making Laying and Maintaining Submarine Cables, and Contractors for Underground and Aërial Telegraphs.

Iron and Steel Telegraph Buoys, Grapnels, both Patent and Ordinary; Centipedes, Creepers, Mushrooms, Sinkers, Cable Tanks, Picking-up and Paying-out Machinery, Dynamometers, Bow and Stern Gear, Steam and Hand Hauling Gears, Ropes and Chain Fittings, Cable Drums, Splicing and Jointing Tools, &c., &c.

Machinery Designed and Constructed for the Complete Equipment of Telegraph Cable Factories and Vessels. Steam and Hand Wire Sounding Machines for Deep and Shallow Water.

All Apparatus and Material used in the Construction, Maintenance, and Working of LAND LINES, viz.:—

POLES—Wrought Iron or Composite Poles for Telegraph, Telephone, and Electric Light purposes. House-Top Poles and Fittings.

INSULATORS—*Johnson & Phillips'* Patent Fluid Insulators, and all kinds of the ordinary form, Shackles, Shackle Straps, &c.

WIRE—Iron and Steel Wire, Galvanized, Plain, or Stranded. Insulated Wires of every description.

BATTERIES—Sole Makers of *Higgins'* Patent Bichromate and Cascade Batteries, and all the ordinary forms. Manufacturers of Zinc and Carbon Battery Plates of special quality.

INSTRUMENTS.—Morse, Needle, Bells, Galvanometers, and other Testing Instruments.

Makers of Underground, Aërial, Torpedo, and Field Cables, with Single or Multiple Cores.

Insulated Copper Wires in Vulcanized India-rubber, G.P., Silk & Cotton; Taped, Braided or Lead Covered.

Lightning Conductors of the most approved types.

ELECTRIC LIGHT—{ **Makers of Dynamos, Lamps, Cables, Carbons, &c.**
Sole Makers of the BROCKIE "UNIVERSAL" ARC LAMP.

ELECTRIC LIGHT
LEADS
made to any
specification in
VULCANIZED RUBBER,
&c., &c.

Stock kept ready
for
immediate delivery

CARBON RODS
for
ARC LAMPS,
Solid and Cored,
Black & Coppered,
in all sizes.

A large supply
always
on hand.

ESTIMATES GIVEN FOR COMPLETE ELECTRIC LIGHT INSTALLATIONS.

By Royal Letters Patent.

PATENT ROLLED
SHAFTING
IN IRON AND STEEL.

The Kirkstall Forge
Company, Leeds,
SOLE MAKERS.

BUTLER'S PATENT FRICTIONAL COUPLINGS.

SILVER MEDAL, INTERNATIONAL ELECTRIC EXHIBITION, 1882.

ESTABLISHED 1868.

ESTABLISHED 1868.

Contractors to H.M. Postmaster-General, the Indian Government, the principal Railway, Telephone, and Electric Light Companies.

MANUFACTURERS, BY PATENT PROCESSES, OF
GLOVER'S PATENT COVERED IRON WIRE FOR AËRIAL LINES.
GLOVER'S PATENT COVERED GUTTA PERCHA WIRE
FOR LEADING-IN, TUNNEL, AND UNDERGROUND WORK.
FANCY TELEPHONE WIRE AND TERMINAL CORDS.
SILK AND COTTON COVERED WIRE OF ALL CLASSES.
SPECIAL MAKES OF ELECTRIC LIGHT LEADS, CABLES AND MULTIPLE WIRE FOR THE VARIOUS SYSTEMS.
ALL CLASSES OF
AERIAL and UNDERGROUND CABLES, and SPECIAL ANTI-INDUCTION CABLES for the TELEPHONE.

WALTER T. GLOVER & CO.,

ELECTRICAL WIRE AND CABLE MAKERS,
SALFORD, MANCHESTER.

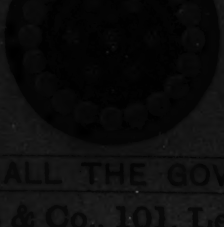
WORKS:— Bridgewater Street, Broughton Road. / Salford Electric Wire Works. / Springfield Lane Cable Works. — **SALFORD.**

PARIS ELECTRICAL EXHIBITION, 1881, GOLD MEDAL AWARDED.

FELTEN AND GUILLEAUME,

CARLSWERK, MÜLHEIM-ON-RHINE GERMANY,
MANUFACTURERS OF ELECTRICAL CONDUCTORS.

- **TELEGRAPH WIRE,** galvanised and plain (to any specification).
- **TELEPHONE WIRE,** galvanised Patent Cast Steel and Manganese Bronze.
- **COVERED WIRES,** for Telephones and Electric Lighting.
- **GUTTA PERCHA and INDIA RUBBER CORES.**
- **TELEGRAPH AND TELEPHONE CABLES (ANTI-INDUCTION).**
- **TORPEDO and FIELD TELEGRAPH CABLES.**



- **LEAD-COVERED CABLES,** for Electric Lighting, Transmitting Power, for Telephony and Telegraphy.
- **CABLES FOR BLASTING PURPOSES.**
- **DYNAMO MACHINE WIRES.**
- **IRON and STEEL WIRE** of every description and for all purposes.
- **WIRE ROPES,** for Mining, Transmission, Street Tramways, &c.
- **FENCING WIRE, STRAND,** &c., &c.

CONTRACTORS TO NEARLY ALL THE GOVERNMENTS IN THE WORLD.

Sole Agents: W. F. DENNIS & Co., 101, Leadenhall Street, London, E.C.
AND 28, STRAND STREET, LIVERPOOL.
STORES: MILLWALL DOCKS, LONDON, E.

THE TELEGRAPHIC JOURNAL AND
Electrical Review.
VOL. XVII.—NO. 408.

THE BRITISH ASSOCIATION.

SECTIONAL ADDRESSES.

Mathematical and Physical Section.

Abstract of Address by Prof. G. CHRYSTAL, M.A., F.R.S.E., President of the Section.

THERE are few things where the want of an enlightened scientific public strikes an expert more than in the matter of scientific text books. If the British public were educated as it ought to be, publishers would not be able to palm off upon them in this guise the ill-paid work of fifth-rate workmen so often as they do; nor would the scientific articles and reviews in popular journals and magazines so often be written by men so palpably ignorant of their subject.

We all have a great respect for the integrity of our British legislators, whatever doubts may haunt us occasionally as to their capacity in practical affairs. The ignorance of many of them regarding some of the most elementary facts that bear on every-day life is very surprising. Scientifically speaking, uneducated themselves, they seem to think that they will catch the echo of a fact or the solution of an arithmetical problem by putting their ears to the sounding-shell of uneducated public opinion.

All of you who have taken any practical interest in the organisation of our educational institutions must be aware of the great difficulty in securing the services of non-professional men of sufficient scientific knowledge to act on school boards, and undertake the direction of our higher schools. It is no secret among those who carefully watch the course of the times in these matters that our present organisation is utterly insufficient; that it has not solved, and shows every day less likelihood of solving, the problems of higher education. This arises, to a great extent, from the fact that a scientifically educated public of the extent presupposed by that organisation really does not at present exist.

If the existence of a great scientific public be as important as I think I have shown it to be, it must be worth while to devote a few moments to the consideration of the means we adopt to produce it both in the rising and in the risen generation.

It would naturally be expected that we should look carefully to the scientific education of our youth, to see that the best men and the best means that could be had were devoted to it; that we should endeavour to make for them a broad straight road to the newest and best of our scientific ideas; that we should exercise them when young on the best work of the greatest masters; familiarise them early with the great men and the great feats of science, both of the past and of the present; that we should avoid retarding their progress by making details and illustrations or particular rules and methods ends in themselves. Granting that it is impossible to bring every learner within reach of the fullest scientific knowledge of his time, it would surely be reasonable to take care that the little way we lead him should not be along some devious by-path, but towards some eminence from which he might at least *see* the promised land. The end of all scientific training of the great public I take to be, to enable each member of it to look reason and nature in the face, and judge for himself what, considering the circumstances of his day, may be known, and not be deceived regarding what must to him remain unknown.

Let us confine ourselves for the present to the most elementary of all the exact sciences, viz., geometry and algebra. These two, although among the oldest, are, as Prof. Cayley very justly reminded the Association not long ago, perhaps the most progressive and promising of all the sciences. For our teaching of algebra, I am afraid, we can claim neither the sanction of antiquity nor the light of modern times. Whether we look at the elementary, or at what is called the higher teaching of this subject, the result is unsatisfactory. In the higher teaching I have to complain of the utter neglect of the all-important notion of algebraic form. I found, when I first tried to teach University students coordinate geometry, that I had to go back and teach them algebra over again. The fundamental idea of an integral function of a certain degree, having a certain form and so many coefficients, was to them as much an unknown quantity as the proverbial x. I found that their notion of higher algebra was the solution of harder and harder equations. The curious thing is that many examination candidates, who show great facility in reducing exceptional equations to quadratics, appear not to have the remotest idea beforehand of the number of solutions to be expected; and that they will very often produce for you by some fallacious mechanical process a solution which is none at all. In short, the logic of the subject, which, both educationally and scientifically speaking, is the most important part of it, is wholly neglected. The whole training consists in example grinding. What should have been merely the help to attain the end has become the end itself. The result is that algebra, as we teach it, is neither an art nor a science, but an ill-digested farrago of rules, whose object is the solution of examination problems.

The history of this matter of problems, as they are called, illustrates in a singularly instructive way the weak point of our English system of education. They originated, I fancy, in the Cambridge Mathematical Tripos Examination, as a reaction against the abuses of cramming bookwork, and they have spread into almost every branch of science teaching—witness test-tubing in chemistry. At first they may have been a good thing; at all events the tradition at Cambridge was strong in my day, that he that could work the most problems in three or two and a-half hours was the ablest man, and, be he ever so ignorant of his subject in its width and breadth, could afford to despise those less gifted with this particular kind of superficial sharpness. But, in the end, it came all to the same: we were prepared for problem-working in exactly the same way as for bookwork. We were directed to work through old problem papers, and study the style and peculiarities of the day and of the examiner. The day and the examiner had, in truth, much to do with it, and fashion reigned in problems as in everything else. The only difference I could ever see between problems and bookwork was the greater predominance of the inspiriting element of luck in the former. This advantage was more than compensated for by the peculiarly disjointed and, from a truly scientific point of view, worthless nature of the training which was employed to cultivate this species of mental athletics. The result, so far as problems worked in examinations go, is, after all, very miserable, as the reiterated complaints of examiners show; the effect on the examinee is a well-known enervation of mind, an almost incurable superficiality, which might be called problematic paralysis—a disease which unfits a man to follow an argument extending beyond the length of a printed octavo page. Another lamentable feature of the matter is that an enormous amount of valuable time is yearly wasted in this country in the production of these scientific trifles. To the occasional working and propounding of problems as an aid to the comprehension of a subject, and to the starting of a new idea, no one objects, and it has always been noted as a praiseworthy feature of English methods; but the abuse to which it has run is most pernicious.

All men practically engaged in teaching who have learned enough, in spite of the defects of their own early training, to enable them to take a broad view of the matter, are agreed as to the canker which turns everything that is good in our educational practice to evil. It is the absurd prominence of written competitive examinations that works all this mischief. The end of all education now-a-days is to fit the pupil to be examined; the end of every examination not to be an educational instrument, but to be an *examination* which a creditable number of men, however badly taught, shall pass. We reap, but we omit to sow. Consequently our examinations, to be what is called fair—that is, beyond criticism in the newspapers—must contain nothing that is not to be found in the most miserable text-book that any one can cite bearing on the subject. First, it follows that lectures should contain nothing but what is to be found in every text-book; secondly, lectures are therefore useless, since it is all in the text-book; thirdly, the examination should allude to nothing that is not in the text-books, because that would be unfair; fourthly, which is the coach or crammer's deduction, there should be nothing in the text-book that is not likely to be set in the examination. The problem for the writer of a text-book has come now, in fact, to be this—to write a booklet so neatly trimmed and compacted that no coach, on looking through it, can mark a single passage which the candidate for a minimum pass can safely omit.

The cure for all this evil is simply to give effect to a higher ideal of education in general, and of scientific education in particular. Backward as we are here, we are stirring. The University of London, after rendering a great service to the country by forcing the older universities to give up the absurd practice of restricting their advantages to persons professing a particular shade of religious belief, has for many years pursued its career as a mere examining body. It has done so with rare advantages in the way of Government aid, efficient organisation, and an unsurpassed staff of examiners. Yet it has been a failure as an instrument for promoting the higher education—foredoomed to be so, because, as I have said, you must sow before you can reap. At the present time, with great wisdom, the managers of that institution have set about the task of really fitting it out for the great end that it professes to pursue. If they succeed in so doing, they will confer upon the higher education one of the greatest benefits it has yet received. They have an opportunity before them of dethroning the iron tyrant Examination which is truly enviable.

All the same, the task of reformation is not an easy one. Examinations have a strong hold upon us, for various reasons, some good, some bad, but all powerful. In the first place, they came in as an outlet from the system of patronage, which, with many obvious advantages, some of which are now sorely missed, had become unsuited to our social conditions. There is a certain advantage in examinations from the organiser's point of view, which any one who, like myself, has to deal with large quantities of pretty raw material will readily understand. It is only when the answers are dissected in the examiner's study that the rottenness is revealed underlying the fair outward skin. But then the examiner must go by his standards; he must consider what is done elsewhere, and what is to be reasonably expected. Accordingly he takes his report and quickly writes so many per cent.

passed. Then the chorus of reporting examiners lift up their voices in wonderful concordance; and all, perhaps even the examiners, are comforted.

In conclusion, let us consider for a moment what might be done for the risen generation, who are too old to go formally to school, and yet not too old to learn. In their education such bodies as the British Association might be very helpful. Indeed, in the past, the British Asssociation has been very helpful in many ways. It can point to an admirable series of reports on the progress of science, for which every one who, like myself, has used them, is very grateful. It is much to be desired that these reports should be continued, and extended to many branches of science which they have not yet covered.

The Association has at present, I believe, a committee of inquiry into science-teaching generally. This is typical of a kind of activity which the Association might very profitably extend. This Association, with its long list of members bristling with the names of experts in every science, not drawn from any clique or particular centre, but indiscriminately from the whole land, might take upon itself to look into the question of scientific text-books and treatises. Even if it did not set up a censorship of the scientific press, which might be an experiment of doubtful wisdom, although some kind of interference seems really wanted now and then, it might set itself to the highly useful work of filling the gaps in our scientific literature. There is nothing from which the English student suffers so much as the want of good scientific manuals. The fact is that the expense of getting up such books in this country is so great, and the demand for them, though steady, yet so limited, that it will not pay publishers to issue them, let alone remunerate authors to write them. Might not the British Association now and then request some one fitted for the task to write a treatise on such and such a subject, and offer him reasonable remuneration for the time, labour, and skill required?

Another field in which the Association might profitably extend its labours appears to me to be the furnishing of reports, from time to time, on the teaching of science in other countries, and the drawing up of programmes of instruction for the guidance of schoolmasters and of those who are reading for their own instruction. In such programmes the bearing of recent discovery on the elements of the various sciences could be pointed out, and the general public kept in this way from that gross ignorance into which they are at present allowed to fall.

The concentration of scientific activity in metropolitan centres is beginning to have a depressing effect in Great Britain. This is seen in the singularly unequal way in which Government aid is distributed over the country. The result is that local effort languishes, and men of energy, finding that nothing can be done apart from certain centres, naturally gravitate thither, leaving provincial desolation to become more desolate.

I think that our great scientific societies—the Royal Societies of London and Edinburgh and the Royal Irish Academy—might do more than they do at present to prevent this languishing of local science, which is so prejudicial to the growth of a scientific public. Besides their all-important publishing function, these bodies have for a considerable time back been constituted into a species of examining and degree-conferring bodies for grown-up men. That is to say, their membership has been conferred upon a principle of *exclusion*. Instead of anyone being *admitted* who is willing to do his best, by paying his subscription or otherwise, to advance science, every one is *excluded* who does not come up to the standard of a certain examining body. Now, against this proceeding by itself I have nothing to say, except that it appears to belong to the pupillary age both of men and nations. It is not the honouring of the select few that I think evil, but the exclusion of the unhonoured many. The original intention in founding these societies was to promote the advancement of science. How that is done by excluding any one, be it the least gifted among us, who is honestly willing to contribute his mite towards the great end, fairly passes my comprehension. If it is thought necessary, for the proper cultivation of the scientific spirit among us, that the degree-conferring function should be continued, let there by all means be an inner court of the temple, a place for titular immortals; but let there be a court of the Gentiles, where those whose fate or whose choice it is to serve science unadorned may find a modest reception. I believe that the adoption of this suggestion would enormously extend the usefulness of our great scientific societies, and give to their voice a weight which it never had before. At all events, if the trammels of tradition, or some better reason with which I am unacquainted, should prevent them from broadening their basis in the way I indicate, nothing prevents the British Association, with its more liberal constitution, from considering what may be done for the scientific plebeian.

There is one other function of the British Association in connection with which I wish to venture another suggestion. During the annual meeting, scientific men have an opportunity of making each other's acquaintance. Great men exchange ideas with great men; and, most important of all, young and little men have a chance, rarely otherwise afforded, of taking a nearer view of the great. What I would suggest for consideration is, whether it might not be possible to form an organisation which would in a certain sense carry this advantage through the whole year. I have already alluded more than once to the difficulties that the scientific public—and here I include professional men generally, in fact all but the leaders of science—have in keeping pace with recent advances. Would it not be possible to have an arrangement enabling at least every large centre of the higher education to have periodically the benefit of communion with and instruction from the high priests of the various branches of science? How glad we, the teachers of science in Edinburgh for example, would be to have a course of lectures once every three or four years from Professors Cayley, Sylvester, Stokes, Adams, Lord Rayleigh. In this way effect would be given to the principle which cannot be too much insisted upon, that the power of the spoken word far exceeds that of the written letter. Not only should we learn from the mouths of the prophets themselves the highest truths of science, but the present generation would thus come to know face to face, as living men, those whose work will be the glory of their time and a light for future ages. From the want of a proper circulating medium, the influence of great scientific men very often does not develop until they and the secrets of their insight have gone from among us. The object of what I propose is to make these men more of a living power in their own lifetime.

THE BESSBROOK-NEWRY ELECTRIC TRAMWAY.

ON Thursday last week this line was officially inspected by order of the Board of Trade. At 12 o'clock one of the electrical locomotive carriages drew up at the Edward Street terminus, three waggons being attached to make up a train. It was then driven towards the Bessbrook terminus, frequent stoppages being made along the way to enable General Hutchinson to examine the line, the result of which will not be made known for some days. Although the formal certificate sanctioning the line has not arrived, we understand that the gentlemen who made the inspection on the part of the Board of Trade "passed the line" without suggesting any alteration. The electrical energy, as in the Portrush line, is generated entirely by means of water-power, and the electrical equipments in all particulars were designed and carried out by Dr. Edward Hopkinson, of Manchester, who undertook the electrical portion of the work in connection with the Portrush tramway. The Bessbrook line is, however, in advance of the latter in many and important particulars. The Portrush line is two miles longer, but only the passenger traffic is provided for by means of electricity, and that only to a partial extent, whereas in the Bessbrook line neither goods nor passengers have any other motive power than the electrical locomotive. The maximum gross load is 26 tons. The train consists of six waggons carrying two tons each, and the electrical locomotive weighing eight tons; the latter being also a car which accommodates 34 passengers. The load is therefore very considerable, and it can be brought up an incline of 1 in 85 at a speed of seven miles per hour. At any point on the line the tram can be started even at the steepest incline and with perfect ease. At Millvale, which is two-thirds the distance from Newry, the water-power is provided where a turbine capable of developing 65 horse-power is erected, the builders being Messrs. M'Adam, of Belfast.

There are two generating dynamos constructed by Messrs. Mather and Platt, of Manchester, on the Edison-Hopkinson type, specially designed by Dr. Edward Hopkinson for the purposes of this line. The current from the generating dynamos is conveyed from a convenient switch-board to a centre rail which runs the whole length of the line, and from this rail the current is conducted to the motors on the car. These have also been manufactured by Messrs. Mather and Platt, and are of the Edison-Hopkinson type. They are capable of working up to 25 horse-power. The car is so geared as to be able to run at a maximum speed of 15 miles per hour, and this speed is easily attained. The two cars which constitute the passenger department of the rolling stock, and which are fully equipped with the already described electrical arrangements, have been built by the Ashbury Carriage Company, of Manchester, and are fitted up in a chaste and substantial manner. At each end of the line there is a loop, so that the car always runs in the same direction, and there is no need to reverse it, which can, however, be very easily done. A simple plan has been adopted of bridging the long level crossing at Millvale. Conductors are carried overhead, and from these a collector on the roof of the car takes up the current, and brings it to the dynamo; in this way there is no difficulty in bridging any passing place. This plan, we learn, has been patented by Dr. John Hopkinson, F.R.S., and would be applicable for the whole line if so desired. The permanent way has been constructed under the direction of Mr. J. L. D. Meares, C.E., of Newry, as chief engineer, and is of solid, and at the same time cheap, construction throughout.

We congratulate the directors, and those associated with them, on the successful completion of this undertaking, and we trust that the results attending the trial trips on this line will be the means of showing the way for a great development in electric tramways.

THE INSTITUTION OF CIVIL ENGINEERS.

WE have received from the secretary of this institution copies of a list of subjects upon which the council is at present inviting original communications. The scheme embraces no less than 42 subjects bearing on questions of professional interest, amongst them being several connected with electrical science. These we reproduce in the interests of our readers, further particulars, such as instructions for preparing the communications being obtainable on application to the Secretary.

Subjects.

3. The Thermic Properties of Metals commonly used in the Arts, especially with respect to Conductivity and Diathermancy at high temperatures.

9. The Testing of Work done by Motors and Machines.

10. Analysis of different types of Steam Engines as shown by Independent Testing.

17. High-speed Engines for Dynamos and Launches.

26. The Economical Construction and Operation of Railways in countries where small returns are expected.

31. Explosions in Coal Mines; their Causes, Warnings, and Prevention.

33. Underground Haulage, especially on the application of compressed air and of electrical power.

36. Gold Quartz-crushing and amalgamating appliances.

39. Electro-Motors; their theory, practical construction, efficiency and power.

40. The Construction of Dynamo-Electric Machines and their Prime Movers.

41. The Working and Cost of the Treble and Double-Wire Systems of Distributing Currents for Electric Lighting.

42. Thermo-Electric Batteries, and their Application to Electric Lighting, Electro Plating and other purposes.

LIGHTING BY PRIMARY BATTERIES.

CONSIDERABLE interest has been recently manifested in America with regard to the remarkable results claimed for the Kauffer-Goldner primary battery. Details of the tests to which the battery was subjected were reproduced from the *Electrical World* in our issue of August 22nd. In the REVIEW for the 5th inst. will be found a letter from the pen of Mr. J. F. Kelly, commenting on the method of testing adopted, and claiming that Leclanché cells under the same conditions would answer just as well. This communication has elicited the following reply from the inventors:—

"A letter from Mr. James F. Kelly calls into question the adequacy of the test put upon the Kauffer-Goldner battery to verify the claims of the inventors. We take the opportunity to explain what a little consideration should make clear. In the first place, we had already obtained ample evidence of the efficiency of the battery for continuous work, having run the lights five or six hours a day during a period of six weeks, including two runs of sixteen hours without intermission, and this with a single charging of the battery. It was then desired by the parties making the test to measure for themselves the duration of light obtainable from one charge of material, and for the purpose, as clearly expressed in the passage quoted by your correspondent, the test referred to was devised.

"We do not think Mr. Kelly will deny that the test established what was claimed upon this point. Quite another matter, although one of equal importance, is what we may call the sustaining power of the battery. Knowing well that it was capable of working consecutively during periods of five or six hours, and longer, the inventors considered the test, six minutes on and six minutes off for a period of 152 hours, as harder than to run 4 hours out of 24 for 38 days. It would seem that at the end of 24 hours, after having worked 12 hours, and rested, so to speak, 12, the battery would be in poorer condition to begin the second period of 24 hours than after working 4 hours and resting 20, and this for the reason that diffusion—upon which depends the supply of depolariser and removal of waste—is, as is well known, a slow process. We have been unable to find any experiments bearing directly upon this point, and if Mr. Kelly can offer any evidence against our view of the matter we shall be glad to be informed. What we have said about our battery is certainly very different from saying, as Mr. Kelly charges, that a battery that will work well on open circuit will work well on closed circuit. We agree with him that the best test is actual work in the conditions of practice, and by such tests we have already shown the efficiency of our battery."

ELECTRICITY CLASSES.

THE following particulars have been supplied to us as to the arrangements made for the coming winter in connection with courses of instruction in electricity conducted at those institutions in London and the provinces where the subject is treated in relation to its technical applications.

The programme of the *City and Guilds of London Institute* contains a notice that persons wishing to become students of the *Central Institution* must send in not later than September 19th a written application stating the department which they wish to enter, accompanied by a certificate of birth and a short account of their previous training. Students intending to go through the complete course of technical instruction with the view of subsequently obtaining a diploma, will be required to pass an entrance or matriculation examination, to be held on September 29th and three following days. The main purpose of the instruction given at the Central Institution is to point out the application of different branches of science to various manufacturing industries; and in this respect the teaching differs from that given in the universities and in other institutions in which science is taught rather for its own sake than with the view to its industrial application. In order that this instruction may be efficiently carried out, the institution, in addition to the lecture theatre and class rooms, is fitted with laboratories, drawing offices, and workshops; and opportunities will be afforded for the prosecution of original research with the object of the more thorough training of the students, and for the elucidation of the theory of industrial processes. The fees for the complete course are £30 per annum, or for the Physical Department only, £20. The courses in the Physical Department will be specially designed to meet the requirements of persons seeking a technical knowledge of physics, either to enable them to rightly understand the processes carried on in certain industrial operations, or to fit them to become technical teachers. The industry to which attention will, in the first instance, be mainly directed, will be that of electrical engineering, under the superintendence of Professor Ayrton. The laboratory work, which is made the leading feature of the tuition, will for first year students consist mainly of quantitative experiments arranged for the verification of the most important well-known laws, while second year students will be trained to carry out original investigations. For first year students, rooms are fitted up for experiments in electricity, heat, and light; and for second year students a series of rooms for conducting practical work in electrical technology, such as the testing of dynamos, motors, lamps, cables, and the construction and repair of apparatus. During the third year the students will devote themselves almost entirely to that special application of physics which they have decided to follow up.

The *Technical College*, Finsbury, is intended by the *City and Guilds of London Institute* to afford persons of either sex a scientific and practical training for intermediate posts in industrial works; to give supplementary technical instruction to apprentices, journeymen, and foremen, who are engaged during the day; and to prepare for the Central Institution pupils from middle class and other schools. An examination for the admission of day students wtll be held on Thursday, 1st October, and the work of the session commences on the 5th. The department of applied physics and electrical engineering is now under the superintendence of Professor Silvanus P. Thompson, the recently appointed principal of the college. The system of instruction is both analytical and synthetical. The student's attention is first directed to a complete apparatus or machine: its action and the practical results obtained with it are then considered; and, finally, the scientific principles that underlie its correct working are traced out, and those conditions are deduced which will lead to further perfection. The laboratories contain many arrangements of apparatus for an organised series of quantitive experiments, each set being complete in itself, so that students find ready in position all the apparatus necessary for carrying out seriatim a large number of experiments. These having been all performed in the specified order, the student is set to carry out what may be called scientific commercial experiments; that is, experiments of such a kind as a master of works might arrange to be undertaken to enable him, by the application of the principles of science to his trade, to turn out in the best and cheapest form the articles he manufactures. Professor Thompson will also deliver an elementary course of lectures on Wednesday evenings at 8 o'clock, in connection with which there is a special laboratory class on the same evening from 6 to 8; and an advanced course on Mondays at 8 p.m., the laboratory class in connection being from 6 to 8 on the same evening. These courses are especially suited to the requirements of those who are engaged during the day in the various electrical industries. The fees for day students amount to £9 for the session, and the fee for each evening class is 12s. 6d. for the session.

The School of Submarine Telegraphy and Electrical Engineering, 12, Princes Street, Hanover Square, London, W.—This school was established in 1868, and is open throughout the year, so that pupils can enter at any time. Under ordinary circumstances the complete course of instruction may be gone through by a diligent pupil of average ability in twelve months, and the fee for this is one hundred guineas. At the conclusion of it the pupil's attainments are tested by an external examiner, and those who obtain 70 per cent. and upwards of the full marks are awarded the vellum certificate of the school, and are placed upon its register. The percentage of failure at this examination is comparatively small. The system employed combines in a very effective way theoretical with practical instruction, special stress being laid upon proficiency in theoretical knowledge. No student is allowed to enter the advanced class, in which the greater part of the practical work is done, until the managers are satisfied as to his acquaintance with the theory of the subject. The school is thoroughly well equipped with all recent necessary apparatus and appliances. Sir William Thomson in May last expressed his great satisfaction with the state of the school, concluding in these words:—"With these valuable adjuncts for illustration and practical exercise, the fundamental scientific principles are methodically taught in a series of systematic daily lectures and examinations under the superintendence of Mr. Tiddy and Mr. Carpenter, and their able assistants, in a manner which seems to me exceedingly well adapted to benefit their pupils." No previous knowledge of science is necessary for the students entering on their studies, nor a greater acquaintance with mathematics than is usually gained in any good secondary school. The first month or two is devoted to the study of those portions of elementary physics and chemistry which bear upon electricity and cognate subjects, as well as of elementary dynamics and plane trigonometry, the use of logarithims, &c.; the metrical and C.G.S. system of units are fully explained and constantly employed in problems and exercises. When thoroughly familiar with these, the student commences the study of electricity in good earnest. The first division of the elementary class then studies systematically the question of resistances in shunts and derived circuits, the theory of magnetism and of galvanometers, the different forms of which are fully explained. Proofs of Kirchhoff's laws, of Wheatstone's bridge, and of the laws for the joint capacity of condensers in arc and in series, with tests for the same, follow, and these are succeeded by explanations of the principal methods of testing resistances in galvanometers, batteries, &c., the best arrangement of cells for given work, cable tests, fault tests, &c. The increase of conductive resistance by temperature, and the limiting temperature of a wire carrying a current, are then considered, and the course for this class concludes with a careful study of the laws of electrolysis, the relations between the length, diameter, weight, and resistance of wires, the arrangement of cable and land line connections in telegraph circuits, as well as the theory and action of the principal telephones. After passing a satisfactory examination in these subjects, a pupil enters the advanced class, and the time devoted to practical work is largely increased. Several different kinds of dynamos are run in different ways with a gas engine, and drawings are taken of parts of the machines. Accumulators are set up, charged, and discharged. Arc lamps of several makers are run in different ways, tested, and drawings made of their parts. Incandescence lamps are tested with Bunsen's photometer, and their resistance simultaneously measured. Tests for E.M.F., capacity, resistance, &c., are made with delicate Thomson reflecting galvanometers on well-fitted test tables, supplied with condensers, bridges, switches, commutators, keys, &c. Various kinds of voltmeters and ammeters are calibrated; experiments are made with motors, and the practical work of a telephone exchange is demonstrated. In the lectures delivered to this class, the efficiencies of series and shunt machines, their characteristic curves, and their physical theory are dealt with at length, and the details of their construction are explained. Pole armature machines are similarly treated, and the best conditions for the construction of armatures and field-magnets are discussed. The theory of accumulators is elaborated, and the construction and testing of lamps described, as well as that of duplex and quadruplex lines, and complicated telephone arrangements. The theory and use of dynamometers are carefully explained, and the fundamental laws governing the efficiency of motors and machines in the transmission of power are discussed.

The West London School of Telegraphy and Electrical Engineering, 101, Uxbridge Road, London, W., was established three years ago to meet the ever increasing demand for skilled telegraphists. The premises were enlarged at the end of last year, and there is now accommodation for a hundred pupils. No artificial contrivances are used; the instrument rooms are connected by real aerial line wires suspended upon poles 24 feet high, which cross the ground between the two buildings; the instruments are all by the most eminent makers and of the latest Government patterns; and the system adopted is assimilated as much as possible to the actual work of a telegraph office. The training is thoroughly practical, and although the Principals, Messrs. Lynd and Cronin, do not guarantee appointments, they state, as a matter of fact, that all successful pupils trained in the school have obtained situations in post offices. The terms for instruction in sounder and single needle instruments and telegraph office duties are for day pupils 7s. 6d. per week, and for resident pupils 30s. per week. There is now also an engineering division, the principal instructor being Mr. W. Lynd, A.S.T.E., and the mechanical branch being under the supervision of an experienced electrical instrument maker. The fees in this division are from £50 to £70 per annum for non-resident pupils.

Crystal Palace Company's School of Practical Engineering.—Gentlemen desiring to study electro-mechanics are received in this school as extra students. A special term is devoted to instruction in the science of electrical force and the practical application of it to lighting, transmission of power, &c. Those who take this term separately must pass an examination as to their proficiency in mechanical work. If the student can pass also an examination in theoretical electricity he will be put to more advanced work. The fee for the special electrical term is £17 10s.

University College, Dundee.—In this college provision is made for a complete course in electrical engineering. In addition to classes in physics, mathematics, chemistry and engineering, a special course of lectures is given by the Professor of Physics (Prof. Steggall) in electricity and magnetism, and this is followed by another special course by the Professor of Engineering (Prof. Ewing) in electrical engineering. This last course deals with practical electrical measurements, the production of electricity by batteries and by dynamos, the theory and construction of dynamos, the storage of electricity, telegraphy, electromotive power, electric lighting, and the distribution of electricity. Prof. Ewing has also a special laboratory and workshop fitted with the appliances for practical teaching in electrical engineering; this feature of the college is somewhat novel, for the electrical engineering laboratory is distinct from the laboratory of general physics on the one hand, and from an ordinary engineering laboratory on the other. It is equipped with testing instruments for electric light work and for land and submarine telegraphy, as well as with dynamos, dynamometers, and so forth. The complete course extends over three years, but students may take either the whole or any part of it. Full information is given in the Calendar, which may be had by application to the secretary of the college.

The Polytechnic Institute.—The Electrical Department is divided into three sections, viz., 1. Science class; 2. Electrical engineering, instrument making, electric lighting and telegraphy class; 3. Class for practical work by students. The first two sections are carried on by lectures which are well illustrated by apparatus and experiments. During the last twelve months there has been a considerable enlargement of the resources of this section. In the third section students are put through a course of practical work. An electrical laboratory was opened last winter, and is now more fully equipped. In this laboratory will be found apparatus by which the chief laws of electrical science can be proved. As far as students are concerned, the class will include guidance in the making of instruments, such as simple, astatic, tangent, and reflecting galvanometers, condensers, Wheatstone's bridge, resistance coils, small electromotors of various patterns, &c. By the diligent use of these opportunities, students will not only master the technicalities of their science, but will also find themselves in possession of useful apparatus for future work. The instruction is under the direction of Mr. W. Hibbert, F.C.S., who will give a prospective account of the coming session on Monday, October 5th, at 8 o'clock. Mr. Hibbert will be glad to advise each student as to the best course he can follow. Full particulars can also be obtained on application to the Secretary of the Polytechnic Institute, 309, Regent Street, W. At the examination held by the City and Guilds of London in May last, the 1st prize silver medal and £3 for electric lighting (ordinary grade), offered in competition to the United Kingdom was awarded to a student of the Polytechnic class.

(*To be continued.*)

SIR WILLIAM THOMSON'S CURRENT-MEASURING APPARATUS.

SIR WILLIAM THOMSON has by mathematical reasoning been led to expect that a mass of soft iron, if spherical, or of an elongated shape provided the length bears not too great a proportion to the breadth or to the shortest diameter, experiences forces in a magnetic field which are but little affected by residual magnetism, and which are very nearly proportional to the rate per unit of distance, at which the square of the intensity of the magnetic force of the field varies from place to place in any direction; on these principles he has devised a means of measuring electric currents. He makes a conductor of electricity of such a shape and form as to give a magnetic field with suitable variation of the intensity of its magnetic force in a space through which a small piece of soft iron can travel while properly supported for measuring the force required to balance it in any position. A suitable distribution of the electro-magnetic force for some purposes, especially for a very accurate standardiser, is when the square of its magnitude varies through the used part of the field, directly as the distance from a point in the prolongation of the line in which the piece of soft iron moves, because this law makes the force experienced by the piece of soft iron independent of its position in the field. This condition, or any modified condition to give convenient lengths of scale divisions, may be fulfilled by trial, with any desired accuracy by taking a single flat conductor, or a flat conductor doubled back upon itself, and cutting it to different breadths in different parts in the neighbourhood of the space through which the soft iron is to move, the line of motion being approximately parallel

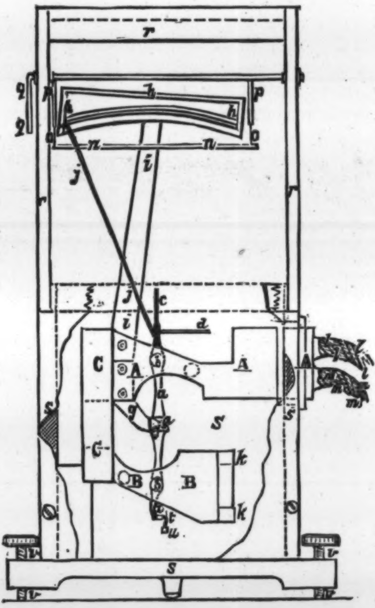


FIG. 1.

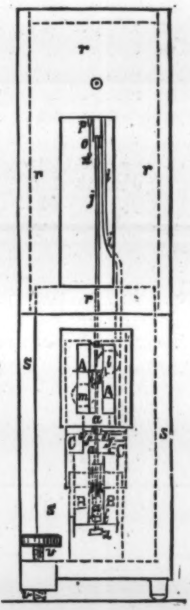


FIG. 2.

to the line of the current. In this case, and when the instrument is designed for use on land, the method preferred for supporting the soft iron is to secure it on one end of a balance arm properly counterpoised, so that the virtual centre of gravity or the whole is as nearly as possible in the line of the bearing knife edges. To counterbalance the action of the electro-magnetic force, the inventor hangs a weight on a knife edge attached to the arm or on a hook attached to the bottom of the piece of soft iron (this last arrangement being convenient when the electro-magnetic force is upwards). The weight is varied according to the square of the strength of the medium current, in the use that is made of the instrument. An instrument for measuring electric currents, constructed according to the foregoing principles, and fulfilling the condition that the motion of the soft iron mass shall be in a direction parallel to the direction of the current, is represented by figs. 1 and 2, these being respectively a view partly in front elevation and partly in vertical section, and a side elevation. In this instrument the balance arm, *a*, carries two soft iron masses, *b*, situated so that each is in a magnetic-field due to the current flowing through the conductor, which is hereinafter more particularly described. The balance arm, *a*, is counterpoised by the arms, *c* and *d*, according to the principles hereinbefore set forth, and is supported by the knife edges, *e*, resting upon the V-grooves, *f*, carried by the plate, *g*. A knife edge support, *t*, is provided at the lower end of the balance arm, *a*, for the suspension thereon of the weight, *u*, employed in the action of the instrument as hereinbefore described. A suitable arrangement for a paper or equivalent scale is carried by the frame, *h*, secured by the arm, *i*, to the conductor of the instrument so as to prevent any error due to shifting relatively to the pointer, *j*, secured to the balance arm, *a*. The conductor of the instrument is of copper and, in the case represented at figs. 1 and 2 of the annexed drawings, is of considerable cross-sectional area as shown more particularly at fig. 2. The conductor consists essentially of two horizontal portions, A and B, connected by the vertical portions, C, but in order to avoid circumlocution it may be supposed to be thus constituted :—two copper plates of the requisite thickness are cut according to the shape of the outline which is at fig. 1 represented as enclosing the three connected parts, A, B, and C, respectively. These plates have their adjacent surfaces parallel and, it may be supposed, are metallically connected at *k* in such a manner that together they form a continuous metallic circuit between the terminals, which upon the annexed drawings are represented in the form of stranded copper wire cables, *l* and *m*. These may be provided with any convenient arrangement for putting the instrument into, or removing it from, an electric circuit. The shape given to the conductors, A and B, at the parts adjacent to the masses, *b*, is that by which the inventor obtains in the field traversed by the said soft iron masses, *b*, by means of a current flowing through the conductor, the requisite disposition of magnetic force. To prevent undue oscillation of the pointer, *j*, he provides a light aluminium tube, *n*, suspended pendulum-wise by two fibres or fine threads, *o*, to the arms, *p*. A crank handle or lever, *q*, outside the case, enables the tube, *n*, by motion of the arms, *p*, to be brought close up to, and to touch the pointer, *j*, and thus, by the friction between the tube, *n*, and the pointer, *j*, stops any such oscillations. A case, having at its upper part a glass front, protects the instrument from currents of air and from dust. The upper part, *r*, of this case is of wood, while the lower part, *s*, consists of an iron casing which surrounds, but is insulated from, the conductor of the instrument, in order to prevent magnetic matter in the neighbourhood from injuriously affecting the magnetic-field or fields of the instrument. The instrument is provided with levelling screws, *v*, and a spirit level to enable the said instrument to be properly adjusted. In order to annul any residual magnetism that may be supposed to remain in the soft iron masses, *b*, the inventor provides a reversing key for effecting rapid reversals of the current.

THE EFFICIENCY AND DURATION OF INCANDESCENT LAMPS.

(*Continued from page 236.*)

As the lamps to be measured in the preliminary efficiency test altogether required upwards of 10,000 photometric observations, it was quite important to avoid the adjustment of a graduated scale, and the horizontal and vertical axes were therefore fitted with notched plates with 12 notches each and spring catches.

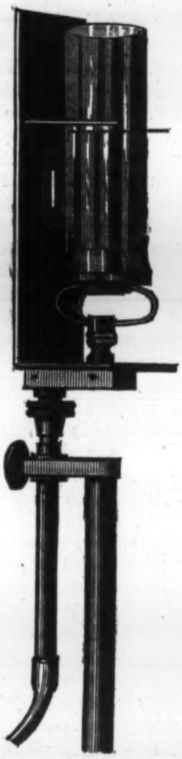


FIG. 4.—METHVEN SLIT AND BURNER.

The plate for the vertical axis had two extra notches, one at 45° and one at 135°. These notched discs permitted very rapid and accurate adjustment. (See fig. 3 in last week's ELECTRICAL REVIEW.)

The Methven standard two-candle slit was used in all the photometric measurements.

The committee are indebted to the courtesy of Mr. Alexander P. Wright, of the United States Electric Light Company, for it and for the fittings for the photometer box.

A certificate accompanied this standard signed by Messrs. Methven & Hartley.

It was deemed wise to verify this standard independently, particularly to discover if any error due to personal equation of observer was present.

Standard English candles, a candle balance and stop watch were used in the comparison.

Ten series of five-minute observations showed an error of one per cent. as the result of 100 observations.

Memorandum of Experiments, Comparing Weston's Methven's Standard with Standard Sugg Candle.

Observed candles.		Time.		Correction multiplier.	Corrected candle-power.
		Min.	Sec.		
(1)	1·722	4	45	1·052	1·81
(2)	1·946	5	...	None.	1·95
(3)	1·853	5	15	0·952	1·76
(4)	2·112	5	18	0·943	1·99
(5)	2·050	5	15	0·952	1·95
(6)	1·974	4	45	1·053	2·08
(7)	2·047	5	10	0·968	1·98
(8)	1·939	4	30	1·111	2·15
(9)	2·057	5	10	0·968	1·99
(10)	2·247	5	10	0·968	2·18
Mean of 100 observations				....	1·984 candles.

Observers : G. M. WARD,
WM. D. MARKS.

March 21*st*, 1885.

A standard Letheby-Bunsen photometer with 60-inch bar was used in the efficiency tests.

Two reflectors in the disc box reflected a circular Bunsen spot in paraffined paper.

The disc was always moved toward the electric lamp on the left in the final balancing of the illumination of the two spots, the wish of the committee being to favour alike the electric lights when in doubt.

It would appear, however, that very near exact justice has been done, since the Methven standard, which proved to have so little error, was treated in the same manner as the lamps.

The particular lamp to be tested being placed in the lamp holder, the potential was adjusted by means of the resistances in circuit with the lamp, and the candle-power, current and potential determined. The current reached the lamp through wires dipping into mercury cups in the piece of wood at the bottom of the lamp compartment. If a change occurred in the potential, photometric work was stopped until the potential was adjusted. Observations of current were taken about every four minutes.

The "reduction factor" used during the test for duration, was obtained by dividing the mean spherical intensity of illumination by the "standard reading" or the mean of the four observations at 0° lat., 0° long.

ELECTRICAL MEASUREMENTS.

The electrical measurements were made in a small room especially prepared for the purpose. The potential of the lamps was measured by a Wiedemann mirror galvanometer in a circuit of high resistance. The instrument employed was made by Hartmann, and was chosen on account of good damping. It had a Siemens bell magnet, suspended in a cylindrical cavity in a solid copper block. The mirror was attached to the suspending rod of the magnet. The fibre was about 15 centimetres in length, and was without appreciable torsion within the deflections used. The deflection of the magnet was observed by a telescope and scale at a distance of 176 centimetres, afterwards increased to 180. The galvanometer resistance was about two ohms, two coils, one on each side of the magnet being used in series, but a resistance of either 50,000 or 100,000 ohms was used in circuit with the instrument, the former being employed with lamps of less than 60 volts potential, the latter with others. The galvanometer was loaned to the committee by Prof. H. D. Todd, of the U.S. Naval Academy, and the reading telescope by Messrs. Jas. W. Queen and Co., of Philadelphia, who (through Mr. Walton, the head of the Philosophical Department) extended to the committee throughout the test every convenience that their large stock of physical apparatus afforded.

During the preliminary measurements for efficiency the potential was regulated by an observer at the telescope, who watched the deflection and recorded the potential at regular intervals, signalling any change to the photometer room, where the potential was adjusted by a change of resistance in the lamp circuit. In general this method worked well, but occasionally, through irregularity of the engine, the potential would fluctuate. Whenever the working conditions were bad, the results were rejected and the measurements repeated.

The lamp currents were measured by a tangent galvanometer specially constructed for the test by Jas. W. Queen and Co. It consisted of a single coil of six turns No. 8 wire, on a brass frame of 60 cm. diameter. The base was of wood, two feet wide, resting on levelling screws. Both galvanometers stood on large wooden posts, buried two and a-half feet in the earth, and out of contact with the floors or walls of the building. The needle and compass were loaned for the test by Mr. Weston. The circle was divided to 10′ and could be read by a magnifying glass to 1′ of arc. The maker's adjustments of the needle in the centre of the galvanometer coil were carefully verified.

The code prescribed the method by which the electrical units should be reproduced, and was strictly adhered to.

CURRENT.

The ampère was determined both by the silver voltameter and by calculations of the constant. During the test 38 calibrations were made of the tangent galvanometer by the silver voltameter. Eight of these were purely experimental, to determine the best conditions, and several of the others were rejected on account of bad conditions. All those were accepted in which the current was steady, the deposit good, and the time accurately determined. The current was supplied at first by a gravity battery, in multiple series, but later by a secondary battery.

A solution of silver nitrate, one-half saturated, was used in a platinum crucible. The anode consisted of a spiral of silver wire, one centimetre in diameter, closely wrapped in filter paper. The crucible was held in a loop of platinum wire. The time of deposit was either 20 or 30 minutes, depending on the strength of the current. The tangent was read on both sides. The deposit was generally in vertical striæ on the inside of the crucible. Some of the later calibrations were made with a 40 per cent. solution, and this gave a finer grained deposit. After the circuit was opened the solution was carefully decanted from the crucible, and the deposit repeatedly washed, the washings being tested with sodium chloride. The washing was continued long after a cloudiness was obtained, and the crucible was dried at a gentle heat over a Bunsen burner. The weighings were made on a balance made by Troemner, of Philadelphia, to tenths of milligrammes. The weights used were verified by comparison with a set of standards in possession of Mr. Troemner.

The constant of the galvanometer, K, is derived from the voltameter determination by the formula,

$$K = \frac{W}{s\, t \tan. \theta}$$

W being the weight of the silver deposit, s Lord Rayleigh's value of the electro-chemical equivalents of silver, taken as ·06708 grammes per minute, t the time in minutes, and θ the mean deflection of the galvanometer.

The error of the galvanometer in reference to the law of tangents was also calculated by the formula given in Kohlrausch's Physical Measurements, and also by Maxwell's formula. Kohlrausch's formula is

$$C = \frac{r\,H}{2\pi n}\left(1 + \tfrac{1}{2}\cdot\frac{a^2}{r^2} - \tfrac{1}{3}\cdot\frac{b^2}{r^2} - \tfrac{3}{4}\cdot\frac{l^2}{r^2}\right)$$

$$\left(1 + \tfrac{15}{4}\cdot\frac{l^2}{r^2}\sin.^2\theta\right)\tan.\theta$$

in which a = half breadth of the coil = ·45 cm.
b = „ depth „ = ·3 „
l = „ length of the magnet = 1·58 „
r = mean radius of the coil = 30·3 „
n = number of turns in coil = 6.

The needle was 3·75 cm. in length, but its effective length between poles was assumed as $\frac{85}{100}$ of this. By substituting the above values, the errors can be calculated for different deflections θ.

By substituting the same values in Maxwell's formula, the error of the coil is found to depend mainly on the coefficient G_1, and to be about $\frac{1}{13000}$.

The code provided that the constant of the tangent should also be determined from absolute measurements. The value of H was determined by a Kew magnetometer kindly loaned by Prof. C. F. Brackett, of Princeton. Owing to the presence of iron in the room, the value of H was found to vary materially with changes of position or height. Two complete observations, each consisting of one set of deflections and two of vibration, were made with the magnetometer needle in the exact place occupied by the needle of the galvanometer. The value of H from the first set was ·19157 and from the second set ·19137. The mean of the two is ·19147. The value of the constant as calculated from the formula

Constant in ampères $= \frac{10\, r\, H}{2\pi n}$, where r = 30·3 cm. and n = 6, is 1·5389.

The calculated errors were plotted in a curve, together with the actual errors as determined by voltameter determinations, and from the mean a table of values of the constant, K, was determined, for different points in the circle, and used throughout the test. None of the reliable calibrations, with the exception of No. 40, indicated any change in H or any defect in the galvanometer, and in this case the discrepancy was but slight.

RESISTANCE.

The ohm was by the code to be the Paris or legal ohm. In reproducing it, the committee had access to the standards and apparatus of the Johns Hopkins University, used by Prof. Rowland in his recent determination. The standard resistances of the test and the Wheatstone bridge used had their values carefully determined in Baltimore.

In the reductions the legal ohm was taken as 1·0112 B. A. units.

ELECTROMOTIVE FORCE.

The volt was determined by the fall of potential in a given resistance due to a known current. A reel of No. 22 German silver wire was made by winding the wire on fine glass rods which were let at each end into pieces of black walnut. The turns of the wire were kept apart by turns of silk cord around the posts. The axis of the reel was surrounded by a stirrer, by which the excessive heating of the wire while in the bath was prevented. This reel was immersed in turpentine and later in refined petroleum (300° fire test, furnished by the courtesy of the Standard Oil Company) and while in use in calibrations the liquid was kept in motion by the stirrer and the temperature regularly recorded. The ends of the wire were taken to double binding posts at the top of the reel, to which the current and potential leads were connected.

The resistance of the reel was determined, on January 5th, at the Johns Hopkins University, as 21·089 legal ohms at 15·2° C. The reel was then placed in turpentine in the exhibition building, and remained for three weeks before the efficiency measurements began.

It was observed that the turpentine was becoming slightly greenish in colour, but no change in the resistance could be detected with certainty by the only bridge at that time in the possession of the committee. As chemical action of some kind was evidently taking place, the reel was removed to a bath of refined petroleum. After the efficiency measurements the reel was again measured, and its resistance was found to have increased to 21·161 at 14° C. In order to determine whether such a change could be due to the chemical action noticed, a gramme of the wire was placed in the turpentine, and in three weeks lost three milligrammes. It was therefore considered by the committee that there was no doubt but that the change of the resistance took place before the efficiency measurements, and the later determination was used in all reductions. After the Wheatstone bridge, loaned by Messrs. Bergmann & Co., of New York, had been calibrated, the resistance of the standard coil was frequently checked. These measurements, extending from – 4° C to + 19°, gave a coefficient of ·0004 for change of resistance per degree Cent.

Calibrations of the potential galvanometer were made by measuring the currents by the tangent galvanometer and simultaneously observing the deflection of the potential galvanometer. The lamp currents passing through the tangent affected the potential galvanometer so that it was necessary to make double readings of the latter with the currents reversed in the tangent.

Each observation with each instrument included two readings on opposite sides of zero, the mean being taken as the true deflection. This method, which was necessary in observations, was adopted for calibrations as well. Calibrations were generally made by the dynamo.

(*To be continued.*)

THE BRITISH ASSOCIATION.

(*Specially Reported for the "Electrical Review."*)

ON THE EMPLOYMENT OF MANCE'S METHOD FOR ELIMINATING THE EFFECTS OF POLARISATION TO DETERMINE THE RESISTANCE OF THE HUMAN BODY.

By Dr. W. H. Stone.

(*Section A.—Mathematical and Physical Science, September 10th*).

At the Southport meeting of the British Association I gave a short account of some observations tending to show that the resistance of the living human body to electrical currrents was considerably, indeed surprisingly, less than that usually given in works on medical electricity and physiology. Even such authorities as Rosenthal in Germany and Dolbear in America assigned values varying from 10 to 100 times the real figure. I produced evidence to prove that this was in the main due to imperfect contact between the body itself and the poles of the measuring instrument. By immersing the patient's extremities in saline solutions, and using large leaden electrodes, this initial error was eliminated, and a fair approximation to the real determination laid before the meeting.

But two secondary difficulties at once presented themselves; first, that the human body possesses considerable electrostatic capacity, and acts as a condenser; second, that it acts as a secondary battery, and sets up a very appreciable counter electromotive force.

In my Southport paper I described a method of alternating momentary contacts with a reversing key, by which the second of these difficulties were minimised. But even on this plan the later readings were always somewhat higher than the earlier, and the resistance seemed to rise slowly to a maximum. This was clearly counter electromotive force, due to polarisation, and the resistance actually noted was the real R., plus an indeterminate polarisation quantity.

So far at Southport. It was, however, there suggested to me to use the alternating current of an induction coil, and to replace the galvanometer by a telephone.

At this latter method, which is extremely elegant, I worked steadily for the following year, and as I incidentally discovered that the alternating currents of the induction coil introduced to physiological research mainly by Dubois Reymond, had not been measured, I set myself this task first by means of Kohlrausch's dynamometer, and secondly by a modification of Sir W. Thomson's quadrant electrometer.

But from the first the results by this method were so singularly discrepant from those I had obtained by the other that I suspected its accuracy. For instance, in a very tall and athletic man, a student at St. Thomas's Hospital, the resistance from foot to foot was always about 1,000 ω, but by this method never above 600 ω.

It became evident that there were two opposite causes of error, a condenser action spuriously lowering the reading (specially strong with alternating currents), and a polarisation action fallaciously raising it (most marked with continuous currents).

To ascertain the exact amount and proportion of either of these presented a task of no small difficulty, and one indeed at which I am still working. I hope fairly to complete it in time for the Lumleian Lectures which the Royal College of Physicians have requested me to deliver in the early part of next year.

It struck me that the human body, besides being an imperfect conductor, resembled a very leaky condenser,* and is not dissimilar to a faulty submarine cable.

On these points I consulted Mr. Latimer Clark, who referred me to a paper by Mr. Henry Mance, read before the Society of Telegraph Engineers on May 8th, 1884.

By the kindness of Messrs. Clark, Muirhead, and Co., I have been able to procure one of Mr. Mance's beautiful instruments for exhibition at this meeting.

Mr. Mance very kindly assisted me with his advice, and corrected some of my early results, one of which is on the black board.

Now if the R can thus be correctly obtained, the subsequent work is much facilitated. Here I have a few rough results, and am steadily increasing their number.

Throw of Galvanometer for Condenser. Permanent opposite E.M.F. by persistent deflection.

In the cases of Benjamin Wheeler and W. Guthrie, after charging the patient from a battery of known E.M.F., his resistance having thus been correctly obtained, discharge with a key through a galvanometer. W. Guthrie gave thus, after half an hour's charging with 20 volts, a throw of 250 scale divisions and permanent deflection of 110.

DISCUSSION.

The President commented on the practical importance of experiments on the resistance of the human body

Sir William Thomson had no doubt of the efficacy of the method described, or of the great convenience of the rapid mode of action which Dr. Stone had explained. He would suggest for Dr. Stone's consideration, whether after all it would not be better to measure the current by an instrument approximately accurate. A measurement of the current showed the whole variation instead of waiting for it by the balance of the resistances. Wheatstone's bridge was admirable for a resistance that did not vary; but a resistance which was constantly varying was best measured by the ordinary galvanometer. All that was required was to apply a constant difference of potential and keep observing the difference in the galvanometer. They thus got everything that could be obtained by the Wheatstone bridge. With regard to the idea of the human body acting as a secondary battery, it was to be looked upon as acting as a single cell of a secondary battery. The E.M.F. due to each could not be more than a fraction of a volt.

Dr. Stone: I find it about a volt.

Prof. Barrett said that some time ago he experimented on the resistance of the human body. To avoid polarisation be made his then demonstrator, Mr. Stewart, convert the body into a cell, one hand immersed in salt water holding a zinc cylinder, and the other a copper cylinder similarly immersed. The resistance of the simple voltaic cell thus formed, which gave the resistance of the body from hand to hand, was measured by Mance's method, the body being in one gap of the bridge and the known resistance in the other. The results thus obtained gave much lower figures than were then usually obtained, as far as he could recollect, about 700 ohms.

Lord Rayleigh mentioned one point which he did not quite understand—what Dr. Stone described as a condenser action. He did not see what evidence there was of any further action than the resistance.

Dr. Stone said there seemed to be a very sudden action, and that seemed to be followed by a leakage. Where there was a fault in a cable there was the same thing; a jump followed by a deflection.

Prof. Barrett: How do you make contact with your body?

Dr. Stone: The feet are placed in salt and water, and large leaden plates are placed under the feet. Of course, I am open to correction as to the condenser action, but I cannot help thinking there is something in it of the nature of an electrostatic action.

Lord Rayleigh said it was to be hoped that further experiments would be made, for the subject was an important one. It should be remembered that experimenting with high E.M.F. was a very delicate matter, for there was possible danger to life without much warning.

Dr. Stone observed that he used extremely low E.M.F. He found twenty volts to be as much as could be used. He could not get his patients to stand the force spoken of by foreign electricians, such as fifty cells of a Daniell battery.

ON ATMOSPHERIC ELECTRICITY.

By Professor C. Michie Smith.

(*Section A.—Mathematical and Physical Science, September 10th.*)

The commonly accepted opinion that during fine weather the air potential is always positive is not accurate for Madras. There it is found that with a dry land wind (*i.e.*, westerly wind), the potential of the air is usually negative during several hours of the day. In the early morning, and up to about 9 a.m., the potential is usually positive, then it becomes negative, reaching a maximum between 10 and 11 a.m., and continues negative till the sea breeze sets in in the afternoon. During the prevalence of land winds there are frequent local showers, but these are evidently not the cause of the negative readings. Negative readings are never obtained in fine weather, except when the wind is westerly, and not even then unless the ground is dry. A shower of rain which cools the ground makes the succeeding readings positive for some hours. A marked feature during the prevalence of land winds are the great clouds of dust which fill the air, and it seems probable that there is some connection between these dust clouds and the negative electrification of the air.

ON THE THERMODYNAMIC EFFICIENCY OF THE THERMOPILE.

By Lord Rayleigh, F.R.S.

(*Section A.—Mathematical and Physical Science, September 10th.*)

During the last few years the thoughts of many electricians have turned to the question of the possibility of replacing the dynamo by some development of the thermopile; and it is, I believe, pretty generally recognised that the difficulty in the way is the too free passage of heat by ordinary conduction from the hot to the cold junction. The matter may perhaps be placed in a clearer light by an actual calculation, accompanied by a rough numerical estimate applicable to the case of German silver and iron.

---

* In fact it has three attributes. It is a conductor, a condenser, and an electrolyte.

If t, t_0, denote the temperatures of the hot and cold junctions respectively, e the electromotive force per degree Centigrade, the whole electromotive force for n pairs in series will be represented approximately by

$$n\,e\,(t - t_0).$$

The magnitude of the current (C) is found by dividing this by the sum of the internal and external resistances ($R_0 + R$); and the useful work done externally per second is $R\,C^2$. It reaches a maximum when the external resistance is equal to the internal; and its amount is then

$$\frac{n^2\,e^2\,(t - t_0)^2}{4\,R_0}.$$

The value of the internal resistance, R_0, depends upon the dimensions and specific resistances of the bars. Denoting the latter quantities by r_1, r_2, and taking σ_1, σ_2, to represent the areas of section, the common length being l, we have

$$R_0 = n\,l\left(\frac{r_1}{\sigma_1} + \frac{r_2}{\sigma_2}\right);$$

so that the external work per second is

$$\frac{n\,e^2\,(t - t_0)^2}{4\,l\left(\frac{r_1}{\sigma_1} + \frac{r_2}{\sigma_2}\right)}.$$

We will now compare this with the work dissipated by ordinary conduction of heat along the bars.

If Q be the amount of heat conducted by the n pairs, r'_1, r'_2, the *thermal* resistances, then

$$Q = n\left(\frac{\sigma_1}{r'_1\,l} + \frac{\sigma_2}{r'_2\,l}\right)(t - t_0).$$

The fraction of this heat, supplied at temperature t, which might be converted into work by a perfect engine working between the absolute temperature, t and t_0, is $(t - t_0)/t$; so that the work dissipated per second is

$$\frac{n\,J\,(t - t_0)^2}{t\,l}\left(\frac{\sigma_1}{r'_1} + \frac{\sigma_2}{r'_2}\right),$$

where J denotes the mechanical equivalent of heat. The ratio of this to the useful work is

$$\frac{4\,J}{t\,e^2}\left(\frac{r_1}{\sigma_1} + \frac{r_2}{\sigma_2}\right)\left(\frac{\sigma_1}{r'_1} + \frac{\sigma_2}{r'_2}\right),$$

independent of $(t - t_0)$, of n, and of l. It is further evident that the ratio in question does not depend upon the absolute values of the sections, or of the electrical and thermal resistances, but only upon the *ratios* of these quantities. Thus the *efficiency* of the thermopile is independent of the absolute dimensions of the bars, and even of the difference of temperatures at the junctions. The *power* is increased by diminishing the length and increasing the sections to a limit not indicated by these expressions (in which the terminal temperatures are regarded as given), and probably determined in practice by the necessity of conveying the heat to the scene of action.

The resistances being given, the ratio of sections $\frac{\sigma_2}{\sigma_1}$ is to be determined so as to make our ratio a minimum. This happens when

$$\left(\frac{\sigma_2}{\sigma_1}\right)^2 = \frac{r_2\,r'_2}{r_1\,r'_1};$$

and thus we get

$$\frac{4\,J}{t\,e^2}\left(\sqrt{\frac{r_1}{r'_1}} + \sqrt{\frac{r_2}{r'_2}}\right)^2.$$

To turn this into numbers for the case of German silver and iron, we have the following approximate numbers in C.G.S. measure :—

$$r_1 = 2{\cdot}0 \times 10^4, \qquad r'_1 = 1{\cdot}0 \times 10^1,$$
$$r_2 = 1{\cdot}0 \times 10^4, \qquad r'_2 = 5{\cdot}0 \times 10^0,$$
$$e = 3{\cdot}0 \times 10^3$$

The value of J is $4{\cdot}2 \times 10^7$, and for t we will assume 500 (absolute measure). The use of these gives, as the ratio of the work that would be obtained by a perfect engine from the conducted heat to that actually obtained from the thermo-electric force, the number 300; from which we may conclude that the steam engine and dynamo are not likely to be superseded by a German silver and iron thermopile, even though considerable allowance be made for the admitted roughness of the numerical estimate.

As regards other materials, it is interesting to note that the ratio contains as divisor the *square* of the electromotive force per degree.

DISCUSSION.

Sir **William Thomson** said when working on the subject of thermo-electricity many years ago he felt the want of an estimate such as that Lord Rayleigh had now put before them, and he had no doubt this communication would be satisfactory and interesting to the great number who took an interest in thermo-dynamics and thermo-electricity.

The **President** said he might mention that some years ago he had a very painful experience in attempting to use thermo-piles. He got stronger and stronger piles, and got into the difficulty mentioned by Lord Rayleigh. There was also a curious difficulty in that the better the alloys for thermo-electrical purposes, the more brittle and unstable they seemed to be, and it was impossible to keep them in working order for any length of time.

Sir **William Thomson** suggested another question—the relation of thermal to electrical conductivity. They were supposed to be proportionate. If that were so, by getting materials having a greater electrical resistance they should have the benefit of diminished thermal conductivity, and therefore increase the ratio in a manner not suggested by Lord Rayleigh. He doubted whether there was an augmented thermal resistance in proportion to the electrical resistance in the instance which Lord Rayleigh mentioned.

Lord **Rayleigh** said in the case of the more ordinary metals the electric and thermal resistance increased together; but when we came to tellusinoid and such bodies the electric resistance seemed to increase much faster than the thermal.

REPORT OF COMMITTEE ON ELECTRICAL STANDARDS.

(*Section A.—Mathematical and Physical Section, September* 11*th.*)

Report of the Committee consisting of Prof. G. C. Foster, Sir W. Thomson, Prof. Ayrton, Prof. J. Perry, Prof. W. G. Adams, Lord Rayleigh, Prof. O. J. Lodge, Dr. John Hopkinson, Dr. A. Muirhead, Mr. Preece, Mr. H. Taylor, Prof. Everett, Prof. Schuster, Dr. J. A. Fleming, Prof. G. F. Fitzgerald, Mr. R. T. Glazebrook, Prof. Chrystal, Mr. H. Tomlinson, and Prof. Garnett, with Mr. Glazebrook *as secretary.*

The committee reported that the secretary had had constructed a series of coils to serve as standards in terms of the legal ohm. Those standards, in accordance with the resolution of the committee, were constructed on the supposition that the value of the legal ohm is—

1·0112 B.A. units.

The comparisons were made by the methods given in the reports for 1883 and 1884, and the values found were :—

No.	Resistance.	Temperature.
C.C.L. 100	·999515	14·1
C.C.L. 101	·998845	14·1
C.C.L. 102	10·00415	16·7
C.C.L. 103	10·00352	16·75
C.C.L. 104	100·0304	16·05
C.C.L. 105	100·0436	16·05
C.C.L. 106	1000·694	17·4
C.C.L. 107	1000·677	17·45
C.C.L. 108	10006·8	17·35
C.C.L. 109	10006·8	17·35

These standards have also been compared with mercury tube resistances constructed by M. Benoit, of Paris, and a difference of ·00049 legal ohms was found. The legal ohm standards, as constructed by the committee, exceed by this amount those constructed in Paris.

Six coils have been compared with the standards during the year, and the values are given.

The committee hope that arrangements may be made for issuing standards of electromotive force, and for constructing and issuing standards of capacity. In conclusion, they ask to be re-appointed, with the addition of the names of Prof. J. J. Thomson and Mr. W. N. Shaw, with a renewal of the unexpended grant of £50.

ON COOLING OF WIRES IN AIR AND IN VACUUM.

By J. T. Bottomley, M.A., F.R.S.E.

(*Mathematical and Physical Section.*)

(ABSTRACT.)

This paper gives a brief account of recent experiments on radiation of heat from the surface of metallic wires in air and in vacuum. A preliminary paper on this subject was communicated to the British Association at its meeting last year. Since that time the arrangements for experimenting have been greatly improved, and further results have been obtained. The object is to determine in absolute measure the loss of heat from the surface of small wires of various materials, both uncovered and when covered with various coatings, the wires being surrounded with different gases at various pressures, down to the very lowest.

The chief experimenters on this subject in recent times have been Kundt and Warburg and Mr. Crookes. My method of experimenting, which is very different from that of other experimenters, consists in passing a current of known strength through the wire under examination and determining the increase in resistance of the wire, due to heating of the current, when the wire has assumed a permanent temperature with the given current passing through it. When the temperature of the wire has become constant, the heat generated by the current (which can be calculated in absolute measure) must be equal to that emitted at the surface of the wire plus that lost at the ends of the wire. The temperature of the wire at the moment is also ascertained from its resistance (as was done by Siemens in his experiments on resistance of platinum wire at different temperatures, Proc. R.S.,

vol. xix., p. 443); and the emissivity of the surface of the wire can thus be determined in absolute measure.

My recent experiments have been directed to the determination of emissivities in very high vacuums. Using a Sprengel pump with five fall tubes, and a McLeod gauge of improved construction due to Mr. C. H. Gimingham, I have obtained and measured a vacuum with air pressure as low as $\frac{1}{30}$ M. (one thirty millionth of an atmosphere). The wire with which I am experimenting at present is a platinum wire half a metre long and 0·04 cm. in diameter. It is contained in a glass tube about 0·6 cm. internal diameter.

A table of emissivities for metallic surfaces has not yet been completed, but one result obtained with a high vacuum may be quoted. On passing a current of 1·18 ampères through this wire with full air pressure the permanent temperature attained by the wire was 75° C., the temperature of the room at the time being 15°·2 C. On exhausting down to $\frac{1}{19}$ M $\left(\frac{1}{19 \times 10^6}\text{ atmo.}\right)$ and passing the same current, the wire became heated to a good red heat.

DISCUSSION.

The PRESIDENT observed that the experiments bore on a very vexed question, and probably some members of the section would offer some remarks thereon.

Professor OLIVER LODGE said he was very glad Mr. Bottomley had taken up the subject, for it was certainly one in which thorough experiment was required, and he supposed that ultimately some crucial experiments would be made. He could only regard these results as preliminary, but they were in accord with most previous experiments. He could not help thinking that the vacuum obtained by Von Zahn was somewhat better than that obtained by Mr. Bottomley. He should have thought that 2½ hours was much too short a time for obtaining a good vacuum. And then it was almost as difficult to test a vacuum as to produce it. They had no real means of ascertaining whether they had a good vacuum or not. The McLeod gauge is not reliable at excessively high exhaustion.

Sir WILLIAM THOMSON said it was not negative evidence; it was a negative proposition. Pfaff, about the year 1820, found no difference between vacuum and air; and in the more careful experiments made since no difference has been found, but he did not know how high the vacuum had been. It was exceedingly convincing if withdrawing air until only one part in 400,000 was left, made no difference, and pretty strongly supported the proposition that air had nothing to do with it.

Lord RAYLEIGH asked whether, if Mr. Bottomley were to vary his experiment so that the gas prevailing in the apparatus should be hydrogen, and then heated it to red heat, so as to give a residue of oxygen, there would be any chance of its being converted into water, and rendered inoperative. That, it seemed to him, would go further toward getting evidence that oxygen had nothing to do with it than any amount of mere explanation would give. Of course, the exhaustion would really be combined with that.

Prof. BARRETT described a very curious experiment which he came across some years ago in connection with the absorption of gas by solid surfaces, showing the extreme necessity for precautions. When the experimental tube was exhausted, either of glass or brass, and then filled with dried air from the lungs a definite absorption of heat was noticed, which depended on the amount of carbonic acid present, and was, in fact, a measure of that amount. But when a corresponding quantity of pure carbonic acid gas was admitted to the exhausted experimental tube no absorption of heat occurred and none became apparent till the experimental tube was filled with dry air. The air by itself absorbed no sensible amount of heat, but appeared to dissipate the film of CO_2 formed on the tube, and then only the true absorption of heat due to the CO_2 was manifest.

The PRESIDENT said he studied this subject very carefully at one time, and the difficulty, it seemed to him, supposing the facts, was to find intelligible theories to explain them. It would come to that ultimately, of course. They accepted the facts which these facts, as well as others, seemed to indicate. What then? That was what he wished to know; and no doubt many other members of the section wanted to know.

Sir WILLIAM THOMSON remarked that the thing was first to get at the fact; and they all owed something to Prof. Lodge for the way in which he dealt with the subject last year. One result of that would, no doubt, be that many would be induced to experiment in the same direction.

Mr. BOTTOMLEY remarked that as Prof. Lodge had supposed, his experiments were only to be regarded as preliminary; but he proposed immediately to push his investigations forward with the apparatus he had described, which has turned out most convenient and satisfactory so far. With respect to the vacuum, it may be that Von Zahn obtained a better vacuum, but he doubted it; because he thought that the German vacuum pumps are not capable of giving a very high exhaustion—not very much higher than that which he had gone to. Mr. Bottomley had used a German pump—Toepler's Hagen pump—in these experiments; but proposed to replace it at once with a Sprengel. The Hagen pump had worked as well as he could expect, but had only obtained a vacuum of about $\frac{1}{500000}$ atmo. With respect to the duration of the vacuum he ought to have said that the plates had been maintained in a very high vacuum for two days previous to the experiment.

AN ELECTRIC SAFETY LAMP FOR MINERS.

By. J. WILSON SWAN, M.A.

(Section G.—Mechanical Science, September 14th.)

I WISH to bring under the notice of the section the latest result of an attempt to adapt electric light to the requirements of coal mining.

The object is to obtain greater security from the danger of the lamp causing an explosion of fire-damp.

The principle of the Davy lamp is no doubt very beautiful, and I am not prepared to say that that principle, applied as it is with great ingenuity of detail in the construction of the modern safety lamp, is incapable of giving safety under the ordinary normal conditions of coal mining; but I do say, that a well grounded doubt and suspicion rests upon lamps of this class when placed under certain exceptional but not improbable conditions.

So long as the lamp, be it the Davy, the Clanny, the Geordy, the Mueseler, or any of the newer designs, is not subject to a strong gust or abnormally swift current of inflammable gas, it is, if well made, probably quite safe, even in a highly explosive atmosphere; but it is more than doubtful if the best of these lamps is safe in such an atmosphere in a state of abnormally rapid motion, such as a blast or the accidental swing of a lamp may occasion.

The fragile partition of wire gauze which alone presents a barrier to the passage of flame from the lighted wick inside the lamp to an explosive mixture of gas outside is too slight a defence against the danger of explosion. The widely-entertained belief that a certain degree of danger is inseparable from the employment in fiery mines of this species of lamp, has naturally led to the enquiry whether it is not possible to get absolute immunity from the danger I have described by resorting to a different principle of construction.

When it was demonstrated that a small and steady light could be produced in a completely enclosed glass bulb by means of the incandescent electric lamp, imagination instinctively turned to electricity as the agent through which complete safety might be secured. The essential fitness of such a light, totally isolated by a gas-impervious covering from the smallest contact with the outer air, was obvious, and indeed it seemed at the first blush of the matter, and in the enthusiasm born of a new invention, that the problem was already completely solved.

No sooner, however, was the attempt made to realise this attractive idea, than many difficulties presented themselves, and these, on close encounter, proved to be so serious, that what had at first seemed easy of accomplishment, began to wear the aspect of total impracticability.

One of the chief difficulties was to bring the lamp, and the power to light it, within the limits of portability. The first electric safety lamp *evaded* this difficulty by requiring that there should be a general source of current supply, from which, by means of strong flexible conducting cords extending between the lamps and fixed main wires, a great number of lamps could be fed.

Here is a lamp such as would be used under those circumstances, and which has been used, to a small extent, in one or two pits. It consists of a bell of strong glass defended by a cage of wires inclosing a small incandescent lamp. The connection of the lamp with the flexible conductor is so arranged that the enclosure is completely air-tight.

I showed a lamp of this kind at the meeting of the Scientific Societies of Liverpool in 1881, and a few months later at a meeting of the Mining Institute of Newcastle.

It is obvious that this kind of lamp, whether fixed or tethered by a flexible conductor, does not meet all the requirements of coal mine lighting. The passages can, perhaps, to some extent, be lighted by fixed lamps of this type, and some of the workings by movable lamps, that is, movable to a limited extent, through their connection with the fixed main wires by flexible conductors. But the cost of such a system of partial lighting by electricity would be great. The electric mains would be difficult to maintain in the presence of frequent stone-falls and other inevitable accidents, and there would be great waste of light if the system were thoroughly carried out to the exclusion of detached hand-lamps, because it would be necessary to constantly light many passages in which there was little traffic.

A hand lamp, detached and portable—more or less like the ordinary safety lamp—is therefore an absolute necessity. It is a lamp of this kind that I have striven to put into a practical form, and am about to show you.

It consists of two parts, the lamp proper, and the battery. The great difficulty was to make the battery small enough and light enough. But these requirements were complicated with others equally imperative. The battery must not be too expensive either to make or to charge.

The last-named considerations excluded some combinations which, in point of bulk and lightness, might perhaps have had advantages over the kind of battery I have chosen to adopt. The trouble and cost of every day emptying, re-filling and generally keeping in order, several hundred cells of even the simplest and least troublesome of any known type of *primary* cell, appeared to me to put that class entirely out of the question. I was thus forced to consider whether any form of *secondary* cell, which would not require emptying and refilling, could be so constructed as to meet the necessities of the case. It seemed to me possible, without excessive trouble or expense of any kind, to charge several hundred *secondary* cells day by day. This presented little or no difficulty; but to reduce within practical bounds the bulk and weight of a battery of this kind, possessing sufficient power to maintain the necessary amount of light during the required length of time, was a thing by no means easy of accomplishment.

I found by comparing the weight and storage capacity of the most efficient of secondary combinations, namely, the spongy lead and lead oxide combination, which, fundamentally, is that of Planté, that I must be content with a moderate amount of light—with a candle or even less, and the lamp must be so made as to give this light with few cells and small current. By the help of a new kind of filament of exceeding fineness, and at the same time of great strength, I have obtained a lamp which probably requires less current than any lamp hitherto made, viz., ·14 of an ampère. With this current, and an electromotive force of about 12 to 13 volts, the light of half a standard candle is produced; and the energy necessary to sustain this small amount of power during ten or twelve hours can be stored in a set of cells neither too bulky nor too heavy for easy carriage in one hand.

Here is the combined apparatus of battery and lamp. Its weight is 6¾ lbs., the cylindrical case containing the cells measures 8 by 4 inches.

Each of the seven cells composing the battery is constructed in this way:—The core is a lead wire surrounded by peroxide of lead. This is covered by a wrapping of cloth, outside which, and filling the space between the oxide cylinder and the interior lead lining of the containing tube, is a packing of lead filament (a beautiful material invented and manufactured by Mr. Cookson, of Newcastle). The lead filament is in contact with the lead lining, and that, with a strip of lead which forms one of the outward conductors, the lead wire forming the core of the oxide cylinder being the other conductor. The electrolyte is as usual dilute sulphuric acid; adhesion to the lead filament prevents the liquid from spilling if the battery is inclined to one side. The terminals are attached to two elastic strips of brass, and these hold the little lamp between them with a slight end pressure, and in such a simple manner that it is removable in a moment. The lamp is protected against external injury by a very thick glass bull's-eye, and light is economised by a silvered reflector behind the lamp. Two sockets within the case provide the means of connecting the battery terminals with the charging circuit There is also a switch of simple construction which enables the current to be turned off or on the lamp; the object of this is to avoid waste of current by keeping the circuit uncompleted until light is required.

Contact is made and broken within a small cavity in the switch plate containing a single drop of oil. Even without this precaution, there is not the slightest danger of ignition of explosive gas by a spark produced at the switch on opening the circuit.

The spark, on breaking the circuit, is exceedingly minute, so minute, indeed, as to be quite invisible to the naked eye; even in absolute darkness the aid of a lens is required to see it. But, as I have explained, the switch is so arranged that in turning the current off the lamp this minute, invisible spark will not be produced in contact with the atmosphere, but within a covering of oil, or rather there will be no spark, for it will be entirely suppressed.

The switch is, perhaps, a superfluous appendage, for if electric lamps were regularly used in a colliery they would be on the charging circuit until required for use, and might remain lighted until put on the charging circuit again.

After charging the cells, the lid, which has attached to it a carrying handle, is screwed on and locked in the usual way, and then there is no access to the battery without unlocking.

A battery of this size, having an aggregate weight of nearly 5¼ lbs., will yield a current of nearly ·14 of an ampère during 12 hours, with an average available potential of about 12 volts. There is a slight gradual fall of potential, the result of which is that the lamp is a little brighter when first lighted than after it has remained lighted some hours.

I do not venture to count upon a greater amount of light from this current and potential than ½ a standard candle.

By reducing the time of lighting to eight hours, the current may be increased to $\frac{2}{10}$ths of an ampère, and with this current ¾ of a standard candle can be obtained without raising the filament to too high a temperature, and of course by increasing the size and weight of the cells still more light can be had.

The arrangement for charging say 500 lamps would neither be complicated nor costly. A dynamo of very moderate size, absorbing three to four horse power, would be sufficient.

The cells would be ranged on benches in front of fixed wires from the dynamo, and these would be so fitted with coupling plugs that the connecting of several hundred batteries would be the work of a very short time.

The cost of the renewal of the electric lamps would probably be about the same as the cost of filling, cleaning, and keeping in repair Davy lamps, and that I believe is about 2d. per lamp per week.

The supply of oil, for ordinary safety lamps, costs another 2d. per week, and I think that sum would fully cover the cost of charging the batteries for the electric light.

Here, then, is a miner's lamp, to which the appellation of *safety* may be given without any reservation.

Whatever its faults, and I am not so partial a judge as to be incapable of seeing them, this electric lamp possesses at least the capital merit of being *absolutely safe*; free, I believe, from even the suspicion of a possibility of causing an explosion of fire damp. If it is neither so light nor so cheap as the ordinary lamp, it is in both respects at least practicable, and especially is it to be noted that the working cost will probably not be more than that of the ordinary lamps. As regards weight, I am not without hope of being able to reduce it.

Besides its safety, there is one other advantage of occasional importance which this lamp possesses over oil lamps. Oil lamps require air more or less pure to support the combustion of the oil. This lamp requires no air; and there are, unfortunately, times, after an explosion of fire damp, when the air of a pit is so foul that no oil lamp will burn in it. With a Fleuss apparatus for breathing, and the electric safety lamp for lighting, the work of exploration, which could hardly be otherwise accomplished, might be carried on, and this, it is reasonable to hope, would be attended with the saving of life.

DISCUSSION.

In answer to questions, Mr. **SWAN** stated that the lamp was not yet being used, but he intended immediately to construct a number of them.

In answer to Professor Stewart as to whether the lamp could be made to indicate the presence of fire damp,

Mr. **SWAN** said he must confess that that point had exercised his thoughts a great deal. The lamp was not like the ordinary safety-lamp—an indicator of fire damp. How far practical men might consider that a serious job he did not know—he had heard opinions on both sides—but it was perhaps practicable that some attachment to the lamp might be used for that purpose. Mr. Swan further stated that the recurring cost of the lamp would be about £1 a year, and, although the lamps had not been manufactured commercially, he would guess the original cost to be about 24s., or three times the cost of an ordinary mining lamp.

ELECTRIC LIGHTING AND THE LAW.

By DR. LEWIS EDMUNDS.

(*Section G.—Mechanical Science, September 14th*).

IN America most of the larger cities have their chief thoroughfares, with their warehouses, stores, and places of public resort lighted by electricity; and gas as an illuminant is fast becoming a relic of the past. Many of the great towns of the Continent are rapidly advancing in the same way, and electric lighting is making great and successful strides. England alone lags behind. What is the reason?

It cannot be in consequence of our want of mechanical and engineering skill, or of lack of knowledge of electrical science. We are at least on a level with other countries in these matters, yet the progress of electric lighting continues slow, at any rate slow in comparison with the universal request for it.

There is an almost unlimited demand for electricity in preference to gas, even at a much higher price, and if the electric lighting companies had been allowed such freedom as the gas and water companies received in the earliest stages of their development, we should have been by this time well on the way to the general employment of electricity. The stagnation arises not from the fact that electric lighting cannot prove remunerative as a commercial undertaking if left to its own free development, as most other industries have been, but because electric lighting under the conditions imposed by Act of Parliament is commercially impossible. The public supply of electricity is now regulated by the Electric Lighting Act of 1882, and so long as that Act remains unamended or unrepealed there is no opportunity for great development in electric lighting as a matter of public supply.

It was an unfortunate thing for the companies that they ever had to go to Parliament at all. If it had not been that they required special powers to enable them to put their wires under the street, as gas and water pipes are laid, we should never have heard of this Act.

Directly the unfortunate companies sought an Act to give them the necessary powers there was a great outcry about monopoly, and the success of the present gas and water companies was held up to the public as the result of an *unfair* monopoly. Many people seemed to forget that the existing companies are the successful survivors of a large number, a considerable proportion of which have proved great losses. If there had not been some inducement to the original investors in the way of future profit we should probably have had many large towns still without a proper supply of gas and water. The Legislature seemed to forget how much we owe to the encouragement of private enterprise in this country, and that we are indebted to it for a better supply of gas and water than any other country in the world.

But all these facts were forgotten, and the Electric Lighting Act of 1882 was passed as a *general* Act, the provisions of which are to be read with all special Acts which may be obtained, unless expressly provided to the contrary.

The electric lighting companies would not have any ground for complaint if the conditions imposed upon them by the Act had been a reasonable *quid pro quo* for the privilege of taking up roads or footpaths for their own purposes and the monopoly (more or less) of supplying a district. The fault of the Act is in placing such stringent conditions on persons supplying electricity, and in asking so much of them as to deprive them of opportunity to realise an adequate return for their outlay. The public grant certain concessions to a company, and it is just and equitable that conditions should be imposed for the proper performance of the business in respect of which the privileges are obtained. If the public ask too much no one will take the other side of the bargain, and the Legislature extinguishes what it meant to regulate.

The section of the Act which has done nearly all the harm is Section 27, which relates to compulsory purchases by the local authority of undertakings within the Act. The section enacts that—

"27. Where any undertakers are authorised by a provisional order or special Act to supply electricity within any area, any local authority within whose jurisdiction such area or any part thereof is situated may, within six months after the expiration of a period of twenty-one years, or such shorter period as is specified in that behalf in the application for the provisional order or in the special Act, from the date of the passing of the Act confirming such provisional order, or of such special Act, and within six months after the expiration of every subsequent period of seven years, or such shorter period as is specified in that behalf in the application for the provisional order or in the special Act, by notice in writing require such undertakers to sell, and thereupon such undertakers shall sell to them their undertaking, or so much of the same as is within such jurisdiction, upon terms of paying the then value of all lands, buildings, works, materials, and plant of such undertakers suitable to and used by them for the purposes of their undertaking within such jurisdiction, such value to be in case of difference determined by arbitration: Provided that the value of such lands, buildings works, materials, and plant, shall be deemed to be their fair market value at the time of the purchase, due regard being had to the nature and then condition of such buildings, works, materials, and plant, and to the state of repair thereof, and the suitability of the same to the purposes of the undertaking, and, where a part only of the undertaking is purchased, to any loss occasioned by severance; but without any addition in respect of compulsory purchase or of goodwill or of any profits which may or might have been or be made from the undertaking, or of any similar considerations. The Board of Trade may determine any other questions which may arise in relation to such purchase, and may fix the date from which such purchase is to take effect, and from and after the date so fixed, or such other date as may be agreed upon between the parties, all lands, buildings, works, materials, and plant so purchased as aforesaid shall vest in the local authority which has made the purchase, freed from any debts, mortgages, or similar obligations of such undertakers or attaching to the undertaking, and the powers of such undertakers in relation to the supply of electricity under this Act or under such provisional order or special Act as aforesaid within such area or part thereof as aforesaid shall absolutely cease and determine, and shall vest in the local authority aforesaid."

Shortly the section amounts to this. The local authority can, after 21 years, or at their option, after the expiration of any subsequent period of seven years, purchase compulsorily the undertaking within their jurisdiction, at the fair market value of the lands, buildings, works, materials, and plant merely as such without any addition, in respect of compulsory purchase or goodwill, or any profits made in the past, or to be made in the future.

To see the practical effect of this clause, let me take a particular example.

An electric lighting company having obtained powers under the Act proceeds to lay out capital in lands, engines, dynamos, laying down wires, &c.; and for the first few years carries on its business at a loss, making experiments, altering, or often at an enormous outlay changing entirely parts of the plant, fighting against the competition of the local gas company, which will reduce the price of the gas as the lighting by electricity extends—and educating the district to the use and advantages ef the new light. After this, for several years, the undertaking may only just pay, and a further expenditure of capital may be necessary.

To recoup the shareholder for all this, together with a possibility that the company may fail entirely and never pay a dividend, or the whole capital be sunk in apparatus, which may in a year or two be superseded and valueless, there is merely the prospective enjoyment of some possible remainder of the 21 years in which to profit by the investment.

At the end of this time the local authority may, if the concern is successful, and it answers their purpose, purchase the whole undertaking merely at the market value of the lands, buildings, materials, &c., as then existing; without any consideration for capital expended in experiments, or unsuccessful endeavours, and without reference to the past, present, or future profits that may be made.

Would any sensible man be likely to invest capital in such an enterprise?

If the enterprise is unsuccessful it will be left on his hands.

If successful, it will be compulsorily bought by the local authority for the mere value of the plant then in actual use, just when it has become a valuable property and he is beginning to reap the full advantage of his investment.

But this is not all—the hardships of an investor in electric lighting shares do not end here. Suppose the venture does not pay after 21 years, but there is still prospect of making it succeed in time—perhaps by sinking further capital in improving the plant, extending the area of supply, or in many other ways, the whole undertaking may prosper.

But what inducement is there to do this?

The prospect held out by Section 27 of the Act is compulsory purchase by the local authority at the end of any seven year period after this first period of 21 years.

The position of the company after their first 21 years is as bad or worse than before.

From the point of view of the general public, there is another very injurious result of this precarious tenure by the undertakers and the compulsory purchase on the basis explained by the Act. By not giving the promoters any real interest in the undertaking, it would prevent any large expenditure on works, with a view to a permanent and lasting installation; their only object would be to make the maximum profit from the business whilst it lasted without any regard to the future.

The Act seems specially directed against every one but the local authorities. It was, doubtless, thought, at the time, they would be the most fit persons to supply their own districts, and there was a great fear of any monopoly growing up similar to that of the gas and water companies.

But the investor will not give all and take nothing, so the result of the stringent conditions imposed on every one but the local authorities has been to wind up most of the companies. A large number of provisional orders and licences were obtained, but the public would not subscribe the capital under the conditions imposed.

The local authorities are in no way suitable persons for carrying on a speculative undertaking—they have neither the organisation nor the requisite scientific knowledge. They may succeed in a well established undertaking like a gas works, where the experience of innumerable companies and investors in the past is at their service; but they are entirely at sea in a new and risky industry.

The position stands somewhat thus:—

Parliament does not want to give anyone but the local authority a monopoly for more than 21 years.

It will not pay investors unless they get a monopoly for a much longer term.

The local authorities are not fit persons to undertake these speculative enterprises, even if they were justified in using the ratepayers' money for doubtful results.

The consequence is that, in its anxiety to prevent a monopoly, the Legislature has entirely deprived the general public of the comfort and security and other advantages which the electric light offers over all other forms of illumination.

THE TELEGRAPH CONFERENCE.

LAST Tuesday's sitting of the Tariff Committee of the Telegraph Conference, says the *Times* correspondent, "was marked by an incident which has just come to my notice, and which still requires to be detailed, as having introduced a somewhat dramatic element into the otherwise dry proceedings of the Conference. Mr. Floyer, the representative of Egypt, who up to the present had not appeared to take much interest in the proceedings, rose and proposed to reduce by half his share of the rates on the land line from Egypt to England on the condition—which he believed would be accepted—that the other countries through which the line passed would make a similar reduction.

"At first there did not seem to be much objection to this proposal, but presently it was observed that, if the land line rates were reduced, the rates of the Eastern Telegraph Company's cable must undergo a similar reduction, and that the company must suffer a very serious loss. On this the States interested began to withdraw their adherence to Egypt's proposal. During the discussion it was remarked that if Egypt were to declare herself ready to enter the European telegraph *régime* she could claim as a right from the States interested a much greater reduction than the 50 per cent. which they seemed inclined to refuse her. Mr. Floyer rose, and, speaking very deliberately, said that in that case Egypt would enter the European *régime*.

"There was a moment of profound silence, broken only by an exclamation by one of the Eastern Telegraph Company's representatives that that simple declaration would entail on it a loss of £70,000 a year. [This, it appears, would more correctly stand at £60,000.—EDS. ELEC. REV.] Mr. Floyer, after agreeing with the President to prepare a formal declaration for the next meeting, gathered up his papers and withdrew.

"Some twenty-five years ago, when telegraphy was first introduced into Egypt, the Egyptian Government entered into various agreements with the Eastern Telegraph Company, by which it surrendered all its international telegraph rights, and more especially its right to charge transit rates on all messages passing through its territory. Egypt, in fact, sold her birthright for a mess of pottage. By one concession the company carried even the local traffic between Cairo and Alexandria. This was described in the agreement as 'a measure to relieve the Government lines.' while it was not mentioned that the company encashed the receipts, some £4,000 per annum. The company established its own office in the principal towns, Alexandria, Cairo, and Suez, ran their own lines between these places, and became dangerously independent.

"The Government lines hardly existed, and the company encashed all the transit and terminal rates, estimated at from £20,000 to £30,000 a year. For many years Egypt, in telegraph matters, was merely a humble department of this powerful company. She had a nominal autonomy, but little or no income. In 1878 the much lamented General Marriott took charge of the railways and telegraphs of Egypt, and found things in the latter department in such a hopeless condition that he invited to his aid an experienced official from India.

"On Mr. Floyer's arrival, a series of vigorous reforms took place. The concession for the traffic between Cairo and Alexandria expired. The Government service, in one day, took over the work and the income without the engagement of a single additional *employé*. In five years the revenue was trebled, while the expenses remained about the same. But there still remained the great financial loss annually, and the irksome feeling of dependence. It would seem now that, through Mr. Floyer's skilful management Egypt may ask for better terms, and may suggest to the company that it is not well to exact its pound of flesh.

"The situation, therefore, as it now stands is this:—Either the Egyptian Government will recover its long-lost transit rates, or Egyptian merchants will be able to telegraph to England for 7d. a word instead of 1s. 8d. In the latter case the Eastern Telegraph Company loses heavily, but in no case does the Egyptian Government lose anything. Meanwhile, Mr. Pender, M.P., who had returned to England, in the belief that all the important matters demanding his presence here had been disposed of, has come back here as fast as express trains could carry him, in compliance with a telegraphic summons from Sir James Anderson, and it remains to be seen how the agents of the Eastern Telegraph Company will extricate themselves from the dilemma in which they have been suddenly placed by the representative of Egypt."

Later on he telegraphs that Mr. Pender had returned from London. "He has been in negotiation with the delegate from Egypt with the view of the latter obtaining his telegraphic independence and the rates appertaining thereto. Mr. Floyer's arguments appear to have been irresistible, for an arrangement has already been come to, by which he has obtained unconditionally everything he wished for. Egypt has been placed on the same footing in telegraph matters as all other countries, and the resulting terminal and transit rates add £7,000 per annum to her telegraph revenue.

"It would seem that the terms 'European' and 'extra-European' are rather misleading. They express in telegraph matters merely a question of a 10-centime rate, or a 15-centime rate, and have no political or geographical meaning whatever. Japan is thinking of becoming 'European.'

"Mr. Floyer, as an officer of his Highness the Khedive, has succeeded in obtaining for His Highness's telegraphs the same footing as that of other States, and with it the rates formerly encashed by the company represented by Mr. Pender; and he has now obtained a *pied-à-terre* for any further measures which his Government may wish to take."

On behalf of the Western and Brazilian Company, "Major Wood recorded a strong protest against further reductions of tariff on the State land lines of Brazil, which compete for traffic with the cables of the company.

"With respect to Australian telegrams, the companies concerned have agreed to reduce the price per word by 2s., provided the Persian Government undertakes to bear its share of the reduction; but Colonel Champain has not yet given a definite answer to the proposal.

"The committee's draft of administrative rules has been read a second time, and the conditions of the Brazilian delegate for the reduction of the telegraph rates accepted."

NOTES.

Electric Lighting in London.—Messrs. B. Verity and Sons, of Covent Garden, have obtained the contract for the whole of the electric lighting at the new Constitutional Club next to the Grand Hotel, Northumberland Avenue. A view of this new building appeared in the *Graphic* a fortnight ago. There are to be over 700 lamps in all, the light being used in the kitchens, &c.; the machinery being in complete duplicate the total capacity of the entire plant will be 1,500 lamps. High speed engines and the newest type of Edison dynamo machines, made in New York, will be used. Special double-pole safety blocks in earthenware will be used for this installation. No expense will be spared to make this a model installation. We believe Sir Wm. Thomson is to be the advising electrician. The same firm is also installing nearly 600 16-C.P. incandescent lamps in the Criterion Restaurant. Owing to the extensive character of the building the wiring is of a difficult character. The grill room and buffet are already lighted up, the fixtures being glass pendants of quite a new design.

The Lighting of Railway Carriages.—We learn from the latest American exchanges that the Pennsylvania Railroad Company is systematically continuing its experiments with storage batteries and incandescent lamps for the lighting of its parlour cars running between Jersey City, Philadelphia and Baltimore. The cells are charged at Jersey City, and supply the lamps for about seven hours. The arrangement appears to be superior to that of carrying gas in a reservoir, but no statement of the comparative expense has as yet appeared.

The Electric Light in Collieries.—On Thursday week an installation of incandescent lamps, supplied by the Maxim-Weston Electric Light Co., Limited, and fitted up under the supervision of Mr. W. C. Cockburn, their agent in Newcastle, was tested at Ashington Colliery. The aim of the Ashington Company has been to have their heapstead illuminated as perfectly as possible, and no expense has been spared to achieve that end. There are three dynamos, two of which are capable of supplying 60 lamps of 20 candle-power, and 30 of 50 candle-power. At present, however, only about 50 20-candle and 12 50-candle lamps have been fitted. The third dynamo is to work two arc lamps each of 2,000 candle-power. The dynamos are driven by an 8 horse-power engine, by Pigott, of Birmingham, with Pickering's governors.

Telephonic Extension in West Cumberland.—On Tuesday last week, telephonic communication was opened from the Whitehaven Exchange to the Parkside Mining Company's mines at Frizington, and to the mine of the Maryport Hematite Iron Company at Pallaflat. The opening of these routes completes the skeleton of the National Telephone Company's West Cumberland system, with the exception of the projected spur from Workington to Cockermouth, for which sufficient support has not been obtained. By going to the company's Whitehaven call office the general public may converse with Frizington and Pallaflat for a fee of 3d.; with Workington 6d., and with Maryport for 9d. Similarly, people may speak from Workington to Whitehaven, Frizington, Pallaflat, and Maryport for 6d.

Telegraph Enterprise.—We read that a well-known stock and share broker has just given evidence of remarkable enterprise by entering into arrangements with the Post Office to lay private telegraph wires connecting his offices in London, Manchester, and Liverpool. He also contemplates having the communication carried to Glasgow, should the arrangements be satisfactory.

A New Telegraph Ship.—Messrs. Robert Napier and Sons launched from their shipbuilding-yard at Govan, last week, a new steel screw-steamer of about 1,200 tons gross, which has been built to the order of the Eastern Extension (Australasia and China) Telegraph Company. The vessel, the *Recorder*, has a measurement of 230 feet in length, 32 feet in breadth, 16 feet on the main deck in depth, and 24 feet on awning deck in depth. She is intended for the laying, picking up, and repair of the submarine cables of the company. She has been provided with cable gear by Messrs. Johnson and Phillips, of London, and is fitted up for the carrying of cables, Mr. Joseph Birnie, of London, being responsible for her design. The vessel will have a powerful water-lamp on the bridge, and will be fitted throughout with the electric light. She is expected to attain a speed of 12½ knots an hour.

The Accident on the District Railway.—W. H. T., writing to the *Times*, says:—"I have read the evidence given at the coroner's inquest in this case, and was surprised that a most important point has been missed altogether. There can be no doubt that the accident arose from the breakage of the rod actuating the signal, and the failure at the same time of the electric telltale; but even this need not have led to the accident had the requirements of the Board of Trade been fulfilled. In the requirements issued by the Board, which are well known both to engineers and inspecting officers, there is one (No. 3) which reads as follows:—'Any signal which is worked by a wire or rod should be so weighted as to fly to or remain at danger on the fracture of the wire or rod.' I maintain that had this important requirement been complied with the accident could not have occurred, and further inquiry ought to be instituted as to how the signal which failed to fulfil so well-known a rule ever came to be erected or passed."

University College, Bristol.—We are informed that the vacant Chair of Physics and Engineering in this college has been filled by the appointment to the post of Prof. John Ryan, M.A., King's College, Cambridge, D.Sc., London, and Member of the Institute of Mechanical Engineers. Dr. Ryan, who is a practical engineer, has hitherto held the appointment of Professor of Mechanics and Engineering in University College, Nottingham. At Bristol he succeeds Prof. Thompson, now Principal of the Finsbury Technical College, and Prof. Hele Shaw, recently appointed to the Professorship of Engineering in University College, Liverpool.

The Propulsion of Tramcars.—The tramcar accident which took place in Bradford last Saturday, and which resulted in the loss of at least two lives, will not increase the popularity of steam-propelled street cars. The details of the occurrence are familiar to readers of the daily papers, and this renders it unnecessary for us to refer thereto. If, however, it is true that the driver used all the usual appliances to arrest the progress of the engine and to reverse its course, and that the brake was found to be useless, it is high time that the careering of these intensely heavy and not easily checked terrors of the streets should be stopped, and the method of propulsion changed for that which is more easily manageable.

The Bessbrook-Newry Tramway.—From information which reached us on Thursday, we are given to understand that General Hutchinson, the Board of Trade inspector, has officially passed this line without reserve.

The Müller Incandescent Lamp.—In our issue of the 11th instant, we gave an illustration of the "Müller" incandescent lamp as used in the tests by the Franklin Institute, on the efficiency and duration of incandescent electric lamps. This is manufactured in the United Kingdom solely, we are informed, by the Simplex Electric Light Company.

The Antwerp Exhibition.—Gold medals have been awarded at this exhibition to the Kinetic Engineering Company for the Berthoud-Borel conductors, and to Messrs. Paterson and Cooper for their "Phœnix" dynamo.

A Phenomenon in Arc Lamps.—Mr. H. H. Levett writes thus to the New York *Electrical World*:—"A curious phenomenon is noticed if the negative carbon of an ordinary arc lamp is replaced by a piece of copper filed to a blunt point. Instead of fusing, there is merely a slight melting of the point on first starting, after which there is no further melting of the copper. There seems to be a deposition of carbon particles carried from the positive electrode of carbon to the negative electrode of copper which tends to shield the copper. I had a piece of copper taking the place of carbon for three weeks without perceptible diminution in weight. My experiments were conducted on a circuit of 20 ampères, and length of arc of $\frac{1}{32}$ in." Some eight or ten years ago, the late Robert Sabine took out provisional protection in this country for some forms of arc lamps, one having a rod of iron in place of the lower carbon. We assisted in the experiments made with the lamp and, as stated by Mr. Levett, the metal fused only at the point of arc, a molten globule there forming. From mechanical defects in the feeding apparatus and from the ghastly colour of the light, the lamp so constructed was shortly abandoned.

Tenders.—The Great Western Railway Company invites tenders for telegraph wire, instruments, and materials, from November 1st to October 31st, 1886.

Electrical Tramways.—The Bentley-Knight system of tramcar propulsion which appears in its main points similar to that of Mr. Holroyd Smith, has now been in practical operation for 12 months in Cleveland, U.S.A. Its success is undoubted, and a graphic description of a trip on the line is published in our New York namesake of September 5th.

Inventions Exhibition Awards.—We are not a little surprised that exhibitors at South Kensington should have made so little stir in the matter of the awards, which do not seem to have been distributed on an altogether sound basis. Mr. Hargreaves, who exhibited a model of a fire escape, has sent a series of letters to our contemporary *Invention*, which passed between himself and the Secretary of the Jury Commission. From this it appears that a bronze medal was awarded to a Mr. Morell for a fire escape which was never exhibited. However, for full particulars of the transaction, which does not show the action of the jury to the best advantage, we must refer our readers to the last issue of our contemporary.

Engines for Electric Lighting.—That vaunted home of education at South Kensington, says the *Electrical Engineer*, is a hot bed of something of a very different name, and money that ought to be expended in gaining information for public use goes in directions known to but very few besides those in whose direction it does go. By a fortunate fluke, however, nearly all the makers of the high-speed engines in the exhibition have been voluntarily testing their engines in public, and there are few of them who have not had a more or less lively time of it. The results obtained are not, however, at all reassuring, and it is quite clear that the disadvantages attaching to gearing are less than those which result from the uncertainty and very probable failure of most of the very high-speed engines. If it had not been for the large engines in the electric lighting shed, all, or nearly all, of which are by Messrs. Paxman & Co., the lighting of much of the exhibition would have been frequently impossible owing to the failure of the high-speed motors, and Messrs. Paxman & Co. are to be congratulated upon the exemplary performance of their engines. High speeds have never succeeded for very long runs, especially when the engines have been worked up to their full power. At present it is quite clear that moderate speeds have the advantage.

The Invention of the Incandescence Lamp, &c.—Under the above title we have just received a pamphlet reprinted from the *Organe Industriel Hebdomadaire* of Brussels, in which the invention of this lamp is claimed for Belgium. In 1838, Jobard, of Brussels, proposed as a source of light a small carbon in an exhausted receiver, and rendered luminous by means of an electric current. De Chanzy, in 1884, repeated these experiments and patented the divisibility of the electric light. About the same time Starr, of Cincinnati constructed a lamp with a platinum wire, which King afterwards replaced by a filament of carbon. Staite employed iridium in 1848, and in 1859 Du Moncel indicated the different tissues which when carbonised gave the best effects of incandescence. Finally M. Somzée, on November 5th, 1879, obtained a patent in which are given all the essential conditions for the glow lamp as now known, as to the kind of carbon employed, the form and section of the conductor, the means for its preservation and the nature of the receiver or globe. The same arrangements, according to the pamphlet before us, were claimed by Mr. Edison in his two patents of November 20th and December 31st of the same year.

Inventions Wanted.—The following are asked for in the *Inventors' Mart* of last week:—"A good deposited filament, practical and cheap." "A good arc lamp for factory work." "Something new in incandescent lamps, that will be suitable for theatres."

Planetary Electrical Disturbance.—Prof. Osborne Reynolds, in the course of a discussion on the corona, at the British Association meeting, expressed his belief that there is electrical disturbance between the sun and the surrounding planets, and dilated on the importance of this view if it could be established as a fact. He also was inclined to attribute an electrical origin to comets, but disclaimed being the first to advance this view.

The Thinkers (?) of the Present Day.—A contemporary, in referring to the B. A. meeting at Aberdeen in 1859, speaks thus of one of the most eminent men the scientific world ever produced:—"The late Sir C. Wheatstone was also great in the meetings of about this time—a man, however, whose reputation is not free from taint, and one in the opinion of most thinkers of the present day who was greatly over-rated, and whose work was most admirably picked from the brains of poorer but better men." From our own personal acquaintance with the late Professor Sir Chas. Wheatstone we unhesitatingly affirm that the writer of the above, together with most thinkers of the present day, do that eminent man an injustice.

Prevention of Danger from Wires at Hastings.—One of the provisions of the Hastings Improvement Act, 1885, empowers the corporation of that town to make bye-laws for the prevention of danger from telegraph and other wires; but these bye-laws must not extend to the works, &c., of the Postmaster-General, to any undertakers within the meaning of the Electric Lighting Act, to either of the railway companies, nor to any wires, &c., existing at the time of the passing of the Act. Under Section 239, however, these latter may be dealt with within that period in case of imminent danger. The placing of overhead wires, except for the purposes of telegraphy, telephonic communication, or railway signalling, without the consent of the corporation, is prohibited.

Overhead Wires at Worthing.—At a vestry meeting at Worthing (Sussex), last week, a resolution was proposed by Lieut.-Col. Wisden, to the effect that the Waywarden be instructed to withhold his consent to the placing by the Post Office authorities of telegraph posts on any part of the highway, as the same would be an obstruction to the highway, and in many parts where the highway is narrow a dangerous one; the same being also uncalled for, as telegraph wires could be placed underground, where they would not depreciate the value of property as telegraph posts would do. Mr. W. F. Tribe seconded the resolution, and characterised telegraph posts as an excessive nuisance. He would be prepared himself to give £2 towards the cost of laying the wires underground. Mr. Galsford said that he would contribute a similar amount, observing that as the road was very narrow in some parts, telegraph posts would prove a source of danger. Mr. Blinkthorn supported the resolution, which was carried *nem con.* Many of those present could not vote on the question, as they were residents in the local board district, whereas the posts were proposed to be erected outside the same. Mr. Jordan remarked that thanks were due to Mr. Clarke for having endeavoured to extend the telegraph service from Worthing to Findon, and he trusted that, in spite of the opposition which had been encountered, he would be enabled to successfully carry out the scheme.

The Best Form of Dynamo.—A paper bearing the above title was read on the 20th ult., before the National Electric Light Association in New York, by Mr. E. A. Sperry, of Chicago. The compilation is weak in the extreme, and nothing whatever can be learned therefrom, as the following quotations will show:—"The field magnets should be given special attention. Their arrangement should be that which would at once strike the practical mind as being the most natural. . . . The disposition of the quantity or masses of metal in the various parts of the field magnet should be also looked to carefully. . . . That form of electro-magnet most often met with in telegraph construction is perhaps, of all forms, the best, and should be followed as closely as possible in designing fields for dynamo machinery. . . . The best dynamo is that which, with good economy, operates continuously with the least expense." This last remark is about as apt as that celebrated truism attributed to Old Moore, of almanack fame, who is reported to have said that if peace be not preserved war is likely to ensue.

Facilities for Inventors.—We notice the following in the correspondence columns of several of our New York contemporaries:—"I observe that the London School of Electrical Engineering makes the following offer to inventors:—'Inventors provided with every facility and the use of all necessary plant and machinery for testing or working out electrical inventions and improvements of every description. The utmost secrecy guaranteed, and advice given as to commercial value of new inventions. Private rooms and high professional assistance if required.' Is there any reputable school in this country which offers such facilities? I am aware that there are places where one can get work done at high prices, as in any shop, exposed to the gaze of crowds of students and visitors; but I do not know of any such facilities as those above offered. There certainly should be, however, in this home of inventors, with its boasted superiority to other lands.—C. E. F."

Electro-motors.—We have it on the authority of the *Electrician and Electrical Engineer* of New York, that there is an immense field in that city for the introduction of small motors driven by electricity.

Callender's American Establishment.—During the last days session of the Electric Light Convention in New York, an invitation was extended by the Messrs. Callender for the gentlemen present to visit their insulated wire establishment at East Newark, N.J. There might be seen a plant of about 50 arc lamps supplied through overhead, subterranean, and submarine conductors. Messrs. W. O. and W. M. Callender took charge of the visitors, and pointed out the various stages of the manufacture of their well-known bitumen covered wires. The assembled company appeared to be highly satisfied with their inspection of the works and testing rooms.

Killed by a Shock.—Richard Aherns, aged eighteen years, in company with Mike Rees and Joseph and William Sefton were carelessly handling an electric wire of the Louisiana Electric Light Company, on Feliciana Street, New Orleans, between St. Claude and Marais Streets, when the current was turned on and the shock instantly killed Aherns. None of the others were hurt. For some time past Aherns and his friends have been in the habit of taking the wire from around a broom, tieing a stone at the end of it, throwing it over the electric wire, and making it fast to a gate knob. When the current was turned on the boys would take hold of the small wire and feel a tingling sensation.—N.Y. *Electrical Review.*

Electric Railways in Practice.—The New York *Electrician and Electrical Engineer* concludes an article on this topic with the following paragraph:—One of the greatest drawbacks to a new branch of electrical industry, looking from a financial standpoint, is the continual march of improvement, forcing upon the management not only the adoption of new devices, but the actual abandonment of the apparatus which is superseded. This has been the experience in both the telephone and electric lighting fields, and there is no reason for believing that the electric railway will be an exception, especially as there is already a wide divergence in opinion as to the most desirable plan. While we have perfect confidence in the future availability of electricity as an economical method of applying power, it must be intelligently used. Its advantages can and will be demonstrated, and the various practical tests which are now being carried on in this country as well as Europe will eventually be crowned with complete success.

Telephone Cables.—We have received a circular relative to the telephone cables of Messrs. Felten and Guilleaume, which are highly spoken of by the Directors-General of the Swiss Confederation Telegraph Department; the Royal Bavarian Postal and Telegraph Department, the Imperial German G.P.O., and of the Copenhagen Telephone Company.

The British Association.—The Aberdeen meeting of the British Association was practically concluded on Wednesday, although on the following day several excursions of the members were organised. The principal trip was to Elgin, where elaborate arrangements had been made by the Town Council for the reception of the *savants*. A special train left Aberdeen for Elgin early in the morning, returning in the evening. The excursionists were entertained by the citizens of Elgin, and visited the principal sights of the district, including the famous cathedral, the Abbey of Pluscarden, and Spysie Castle. The Invercauld trip, which was one of the most popular, and in anticipation of which a large sum of money had been expended in preparations, had to be postponed in consequence of the indisposition of Colonel Farquharson, but a trip to Ballater and a drive up Deeside were arranged instead. The other excursions, all of them well attended, were to Haddy House, Fyvie Castle, Edzell, Kemnay, Banff, and Portsoy. The total number of persons who had attended the meeting was 2,203, consisting of 225 old life members, 18 new life members, 332 old annual members, 122 new annual mumbers, 1,053 associates, 147 ladies, and six foreign members; the revenue amounted to £2,256. The total sums granted by the Association for research was £1,195. The papers read were generally considered to average considerably better than had been the case for some time past, and the addresses of the Presidents of Sections has attracted considerable attention throughout the country, the opinion being generally expressed that it was absolutely necessary for the country that increased attention should be given to the study of science if foreign competition was to be successfully met. The policy of admitting ladies as officers of the Association was considered. The advisability of adopting a memorial to the Government to undertake the systematic and annual publication of statistics on wages and a periodical census was insisted upon, and a memorial in favour of the establishment of a National School of Forestry was resolved on. It was determined that the meeting for 1887 should be held at Birmingham, under the presidency of Sir William Dawson, the principal of M'Gill College, Montreal. During the week a great increase of duty was imposed on the telegraph and Post Office officials, but the local staff performed their duties without a hitch.

The New Tariff for Telegrams.—On the 1st of October next the new rate for inland telegrams will come into force. The charge will be 6d. for 12 words or less, and ½d. per word afterwards. Every word, including the addresses, will be charged for; but it is anticipated that in the majority of cases the senders of telegrams will need only to have their names telegraphed. In consequence of the change of rate, the following alterations in the mode of counting will be made:—Names of towns and villages will be counted as one word each. Thus "Malvern Wells," which under the former rules was counted as two words, will be only one. Again, figures, which were counted as one word each, will be counted, as in Continental telegrams, at the rate of five figures to a word. Thus, "344, Oxford Street," which under the former rules was counted as five words, will be only three. Initial letters will still be charged for as one word each; but a special exemption has been made in favour of the London district initials. Each set of these will count as one word only. Thus "S.W." will count as one word. The charge for re-direction will be 6d. for a telegram of any length if the two addresses are within the same town. If the addresses are not in the same town the full rate will be charged. For the purposes of this rule each London district is regarded as a separate town.

The Reis Telephone.—We may mention that the writer of the letter which appears in our Correspondence Columns on this subject is himself a German. Prof. S. Thompson will therefore doubtless take this into consideration should he deem the matter of sufficient importance to demand a reply.

Atlantic Cable Competition.—A New York contemporary says:—"We understand Mr. Pender talks of reducing cable rates to 6d., or 12 cents per word; but the Western Union Company objects, it already having suffered enough. The proposed reduction of cable rates is only intended for the purpose of bulldozing Mr. John W. Mackay into a pool, or perhaps it is thought the Mackay-Bennett cable can be forced to a sale. The public have warmly supported Mr. Mackay's cable enterprise, and we believe he is making more money to-day than either of the other cable companies. Hence there is neither inducement nor necessity to pool; and as to selling out, we don't believe Mr. Mackay is the kind of man. He stands to-day a terrible thorn in the side of the Western Union Company, and the entire Atlantic cable interests and the public will sustain him. Neither Pender nor Gould can reach him.

The Blackpool Tramway.—We understand that this line is being rapidly proceeded with. Mr. Holroyd Smith has had three cars running at one time carrying over 100 people, and the horses in the vicinity of the line are gradually getting accustomed to the sight of the cars gliding along without any visible means of propulsion.

NEW COMPANY REGISTERED.

Garw Water and Light Company, Limited.—Capital £30,000 in £10 shares. Objects:—To carry on in all their branches the business of a water works company, a gas works company, and an electric light company for the purpose of supplying various parishes in the County of Glamorgan. Signatories:—C. L. Waugh, M.E., Pontycymmer, 20 shares; J. Walters, Treherbert, 30 shares; E. S. Kynns, Rhondda Valley, 30 shares; E. S. Pike, Rhondda Valley, 12 shares; D. Roberts, Ynore Vale, 20 shares; J. Williams, Tyneuydd, 20 shares; J. Barrow, M.E., Maltsley, 20 shares; W. R. Randall, Bridgend, 30 shares; all in the County of Glamorgan. Directing qualification: shares or stock of the nominal value of £100. The signatories are to nominate the first directors, and the company in general meeting will determine remuneration. Registered 14th, by Mr. C. Doubble, of 14, Serjeant's Inn, Fleet Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

New Electro-Amalgamator Company, Limited.—An agreement dated 21st ult. relates to the purchase by this company of the assets and contracts of the Electro-Amalgamator Company, Limited. The old company having been unsuccessful in carrying on its business, it was resolved, at a meeting of its shareholders held on the 6th ult., that instead of winding up, its assets and contract should be sold to a new company, to be formed with a capital of £6,000, the purchase consideration being the payment of the debts of the old company (not exceeding £3,600), in cash, and one-third of the profits of the new company, after repayment of the amount of £6,000 subscribed; the shares of the new company to be offered *pro rata* to the old company's shareholders.

CITY NOTES.

Pyramid Electric Company, Limited.—A general meeting of the shareholders of this company was held at the offices of Messrs. W. H. and F. S. Collins, St. Mary Street, Ross, Herefordshire, on October 16th, for the purpose of having the liquidator's accounts, showing the manner in which the winding-up has been conducted, and the property of the company disposed of, laid before the meeting.

TRAFFIC RECEIPTS.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending August 31st were £3,780.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th September, are £2,027, as compared with £2,134 in the corresponding period of 1884.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

11908. "Improved electric torch." O. Imray. (Communicated from abroad by E. Arnould, of Paris.) Dated September 2. 6d. Relates to an improved electric torch, or portable apparatus for lighting gas jets by electricity, by means of a thin platinum wire rendered incandescent by the passage of an electric current produced by a Bunsen or other suitable battery, and the apparatus is so constructed that the electric current is only produced when required to light the gas jet.

12754. "Improved apparatus to be used in connection with machinery for covering electrical conductors, which apparatus is also applicable to other purposes." G. C. Taylor and E. T. Truman. Dated September 24. 4d. Relates to an improvement on the apparatus described in patent number 482 of 15th February 1872.

12991. "Improvements in means for applying the electric light to speculums and other scientific instruments." C. Smith. Dated September 30. 6d. The inventor employs an incandescent lamp, which he secures, in any convenient manner, in a hollow metal holder or casing, of such a form that the lamp will be enclosed on three sides, and open on the side which will be furthest from the operator. The holder is conveniently pivotted to a plate of metal which is hinged to a pair of spring clips intended to take on to the edge of the speculum, the lamp projecting more or less as required in front of the bell mouth of the speculum.

1885.

1212. "A new system of and induction current generator for long cable telegraphy." S. Roos. Dated January 28. 6d. The generator is constructed in the form of a cable of indefinite length in the following manner:—A core composed of a suitable number of parallel straight iron wires is covered with a tape, the covering being then varnished and paraffined. Upon this core is wound a close spiral, formed of a coarse covered copper wire, which constitutes the primary wire of the generator. This wire is paraffined and covered with a tape, which is then varnished and paraffined. Upon this is wound a close spiral of fine covered copper wire, which constitutes the secondary wire. This is also paraffined, and, in order to protect it, the whole is served with a tape, which is afterwards varnished. The secondary wire may be divided into a greater or less number of sections, of which the beginnings and ends emerge from the cable in the form of flexible conductors. The cable thus formed is wound upon a bobbin, which may, for convenience, be formed by the condenser itself. The two ends of the primary wire communicate with the generator of the inducing current, with the condenser and the make and break. The commencements and ends of the various sections of the secondary wire, communicate respectively with two series of studs in such way that the several sections may be readily connected in tension or quantity at will, and in various possible combinations according to the purpose in view. In employing this generator for long cable telegraphy, the inventor may use the Morse key for transmitting, and receive the signals directly by a telephone as by a Morse sounder.

1831. "The production of materials to be employed in the construction of elements for voltaic batteries and apparatus to be used therefor." D. G. FitzGerald and T. J. Jones. Dated September 25. 6d. Relates to the production of spongy or finely divided lead and peroxide of lead to be employed in the construction of elements for voltaic batteries, and it consists in obtaining, by means of electrolysis, the finely divided or spongy lead in bulk from a paste composed of equivalents of sulphate of lead and magnesia with water or other suitable liquid, or of sulphate of lead with an alkaline solution, and simultaneously therewith the peroxide of lead, either in bulk or as a coherent layer upon the surface of a conductor, preferably of lead from red lead or litharge, or a mixture of either with finely divided lead, or from sulphate of lead (such as the spent materials from the working of lead batteries) which has been treated with an alkaline solution. The invention also relates to the construction of the electrolytic or converting tanks employed, by means of which the inventors are enabled to obtain materials to be employed for elements of voltaic batteries from the above-mentioned or other lead compounds.

2463. "Improvements in secondary electric batteries or electric accumulators." C. S. Bradley. Dated February 24. 6d. Consists of a containing vessel or chamber of any convenient form or material; in the bottom of this vessel is placed an electrode of carbon, platinum, or other suitable material. A second electrode, which may also be of carbon or other suitable material, is suspended or supported in any convenient manner within the vessel above the first electrode. To the electrodes conductors are respectively connected, these may be rods composed of the same material as the electrodes to which they are attached. The cell is then filled with the electrolyte, which is a nearly saturated solution of zinc bromide.

2671. "Improvements in dynamo machines." A. F. Link. (Communicated from abroad by A. G. Helios, of Cologne.) Dated February 27. 4d. Relates to the construction of the pole pieces and other portions of dynamo machines.

3324. "Improvements in telephones." K. S. Dembinski. Dated March 14. 6d. Fig. 1 shows the telephone partly in longitudinal section, and partly in perspective; and fig. 2 shows the way it is fastened to the board. This telephone consists of a box in ebonite, r, having the shape of a wide mouthed tube with two ends; inside this tube is placed a magnet, s, each extremity of which is provided with a thinner part, u, in soft iron, bearing a coil rolled round with fine wire: these thinner parts are screwed to the magnet. Close to the coils are placed the diaphragms in tin plate of ferrotype. One can also make use of a magnet formed of several steel laminæ. The mouth pieces bear a copper muff, being screw cut, v, and capable of supporting a kneed ear-trumpet or a flexible tube, q, terminating by a funnel, w, so that two persons may simultaneously receive dispatches through one single telephone. Two terminals, g, h, serve to receive the wires. This telephone is fixed to a wooden board, y, by means of two rings, z, screwed or attached in any other manner to the board.

Fig. 1.

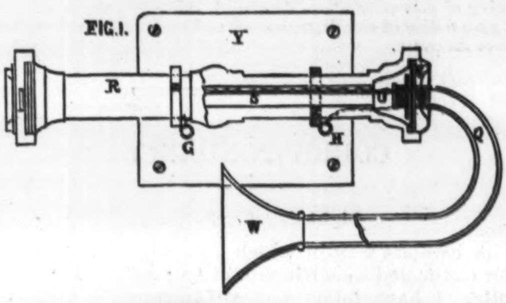
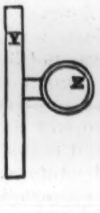


Fig. 2.



4063. "An improved system of electric railway signals." W. T. Waters. Dated March 31. 1s. 2d. Relates to improvements in electric railway signals, the object of which is to provide a uniform system of automatic signals applicable to all the purposes for which stationary signals are required.

4254. "Improvements in acoustic or mechanical telephones." H. Seligman and E. Seligman. Dated April 7. 6d. Consists in the employment of two diaphragms within a single phone with a dividing space between them, and filaments or other suitable connections extending from one to the other and securely attached to both. The securing is the better obtained by using a ring at the terminal of the filaments, and placing said ring against the surface of the diaphragm, the filaments passing through the diaphragm and being utilised for retaining the ring in position by virtue of the tension of the filaments. The diaphragms are arranged upon opposite sides of a globe or hollow casing, and by this means the vibrations of the contained air acting laterally on the connecting filaments serve to materially emphasise the sounds transmitted, and thus increase the power as well as the delicacy of the instrument.

4647. "New electric arc lamp." H. Pieper. Dated April 15. 6d. Consists in a carbon-feeding device substantially comprising two resilient frictional palls actuated through the agency of the electric current, one of the said palls operating to feed the movable carbon, in the measure required, towards the stationary one, the other pall serving to check and retain the movable carbon during the retrograde motion of the feeding pall, the carbon being thus continuously kept under control by the palls and prevented, in case it is arranged vertically, from being acted upon by gravity independently of the palls.

5045. "Improvements in galvanic batteries." T. J. Jones. Dated April 23. 4d. Consists, broadly, in the employment in the manufacture of the supports and contacts of the elements, of platinum or gold deposited on or applied against certain substances which form a foundation for the elements or for the contacts.

5208. "Improvements in fac-simile or autographic telegraphy." P. B. Delany. Dated April 28. 8d. The inventor employs combs (as in the Bonelli apparatus) containing twelve fingers, more or less, at each station in connection with a single main line wire. The wires on the combs at the sending and receiving stations are severally connected one after the other by the synchronous mechanism of the Delany multiplex system.

5218. "An improved fire telegraph system." L. H. M'Cullough. Dated April 28. 6d. An open metallic circuit is employed, and in practice the signal boxes are arranged in multiple arc relation to one another by making a half connection to every box from each of two wires, one of which runs from the positive pole of the battery back to the same pole again, and the other of which runs similarly from and back to the negative pole of the battery, A circuit maker in each box makes the necessary closures of the circuit when an alarm is sent in. By this arrangement it is effected that a signal will be sent in, even though the line should be broken or otherwise defective at a single point between two stations, and in case of two or more defects in the line, only that box or those boxes will be cut out which lie between the extreme defective points. Moreover, an accidental ground caused by contact with a telephone or telegraph or other wire, will have no effect whatever on the apparatus, while in case of the crossing of a loop, as above described, the different engine houses will give notice of the disturbance, and measures can be taken to remove its cause.

CORRESPONDENCE.

Lightning Conductors.

The careless way in which lightning conductors are often connected to earth should be made known to the public. I have lately had an instance in point, in which a chimney stack was supposed to be properly protected. It was situated near tidal water, and the base of the structure was not 3 feet above high tide, so that with ordinary care good earth should have been obtained. I took tests *z* and *c* to line with a Thomson astatic mirror galvanometer and Wheatstone's bridge, and was surprised to find that the lightning conductor had a resistance of 27·4 ohms to earth; a quarter of an ohm would have been more in accordance with the requirements. Here, then, was a conductor offering a dangerously high resistance to the passage of a lightning flash, and was actually attracting the lightning without being capable at the same time of freely discharging the electricity into the earth.

The earth plate for the purpose of this test was buried 15 feet from the conductor. A second test at a distance of 50 feet, in which the plates were in contact with water and gas pipes, gave a reduced resistance 8·3 ohms.

On further examination of the ground I obtained a satisfactory earth of ·21 ohm, to which the lightning conductor will in future be connected.

Another instance has lately come under my notice in which the man who is an erector of lightning conductors persisted in his attempt to fix the end of the conductor direct to a water main with a lump of solder, using for the purpose a small soldering bolt, which would not even warm the iron pipe, much less make the solder flux with the metal. This kind of work must conduce to cracked chimney shafts and walls, faults which are put down generally to a settlement on a bad foundation, or to some unexplained cause. The gentleman is, I understand, in extensive practice and inspires confidence. If a flash strikes a building the conductor will be to blame, or perhaps Mr. Preece's law of the area protected by lightning conductors will appear to be refuted.

But it appears to me that the owners of buildings and insurance companies are themselves to blame for accidents due to lightning; they are satisfied with a word of mouth assurance that the conductor is properly earthed, which either means nothing, or is a cover to unreliable tests, if indeed any have been taken.

When lightning conductors are erected careful tests should be taken of the earths, and the resistances of each should be expressed in ohms and given to the owner in writing, by which the exact conductivity will be ascertained and kept. The locality, also, of the earths should be recorded for future use in testing.

If water pipes have been tested for earth they form the best connections for lightning conductors, and are so recommended by Prof. Jamieson in Munro and Jamieson's Pocket Book of Electrical Formulæ, but the connection, unlike the example above quoted, must be made in a proper manner. Independent earths of copper plate should also be put in.

It may not be generally known that good earths are not easy to obtain in some localities, even when the places are near the sea; in such instances the neighbourhoods of water pipes is most opportune, as they give an extended surface for the dissipation of the electricity. I remember the bad earths obtained in the Island of St. Pierre, where the telegraph signals of the French Atlantic cable station were reproduced at the telegraph office of the Sydney N. S. cable, confusing the messages. I believe bad earths are found in many parts of England and Scotland, and principally in the manufacturing districts, where the older geological formations prevail. Owners of tall buildings should look to the earths of their lightning conductors, particularly in such localities.

E. W. Beckingsale.

Greenock.

Irish's "New" Telephone.

I read with some interest the description of Mr. Irish's new telephone in your issue of 22nd August, and with still greater interest the letter of Mr. Dierman in to-day's issue, by which he claims priority in virtue of his having designed a similar instrument in September, 1884. It may interest both of these gentlemen to know that an exactly similar instrument was in actual use on the Edinburgh Telephone Exchange in the spring of 1880, or five and a half years ago. It formed one of several instruments designed by me for the Scottish Telephonic Exchange, Limited, now merged in the National Telephone Company, Limited, and was manufactured for that company by Messrs. Breguet, of Paris. There is no merit whatever in the design, as it is simply a transposition of the functional elements of an ordinary Bell telephone, and is of course covered by the Bell patent.

J. G. Lorrain.

September 12th, 1885.

You would oblige me very much in correcting a fault which has crept into my letter published in your last issue.

My collaborator was *M. Florent Thienpont, of Etichove*, and we claim the priority of the invention of Irish's telephone, *unless* Mr. Irish had patented his instrument before March, 1885.

W. Dierman.

Ghent, *September 15th*, 1885.

Reis's Telephone.

Will you permit me to ask Prof. Silvanus P. Thompson to reconsider his translation of the German "die Tonsprache selbst," which you publish in his letter in your valuable journal of the 12th inst., as "the very tones of speech." Ought it not to have been "even music itself"? Music is called "die Tonsprache" by German musicians and musical enthusiasts.

G. R.

September 15th, 1885.

Life of Lamps at the Law Courts.

I made sure some one would have written to you last week to point out the fallacy of Mr. A. Grundy's calculations; but as no one did so, and the error is important, would you allow me space for the purpose?

He takes an arbitrary period, divides the total lamp hours of the installation by the number of lamps burnt out, and the quotient stands for the average life. Thus in a new installation, at the end of 100 hours, his method might easily give *infinity* for the average life; after 200 hours, say, 50,000 hours average; and at the end of 50 years perhaps the error would be unimportant. The Greeks said, "Call no man happy till his death," and I would advise Mr. Grundy not to try and calculate (to a decimal!) the average life of a set of lamps the great majority of which are still burning. When they are all burnt out his method will apply, and then, in addition to its simplicity, it will have the advantage of being sound.

X.

September 16th, 1885.

Secondary Generators or Transformers.

In your issue of the 12th instant you published a theoretical report by Dr. Hopkinson, of which the object was to call the attention of electricians to the dangers offered by certain apparatus employed in the distribution of electricity.

After acknowledging that secondary generators have the greatest future before them as regards the distribution of electrical energy, Dr. Hopkinson shows that the actions of the primary coils upon the secondary being of two natures, electro-magnetic and electrostatic, they may be dangerous if the secondary generator were constructed in such a manner that its electrostatic capacity should not be reduced to a minimum.

This observation would directly apply to our disc secondary generators if the many experiments which we have had occasion to make with currents of the highest E.M.F. ever industrially employed had not long since practically shown us the justness of Dr. Hopkinson's observations, not, however, as regards the question of danger, for we have no victim to reproach ourselves with, but rather as touching the preservation of the apparatus, which was a sufficient reason to determine us to take steps to prevent the objectionable effects of electrostatic action.

We have, consequently, constructed our apparatus in such a way as not only to reduce to a minimum the electrostatic action of the primary circuit upon the secondary, but also to entirely suppress this action.

We hold ourselves at the disposal of Dr. Hopkinson for the purpose of giving him all the explanatory indications he can desire as to the means which we have employed to arrive at this result; we are not at liberty to publish these particulars, because the National Company for the Distribution of Electricity by Secondary Generators, Limited, has been sufficiently victimised by our having given, with too great frankness, information upon the apparatus of which that company is the proprietor.

Our only object in writing this letter is to state that our practical experience absolutely confirms the theory of Dr. Hopkinson, and at the same time to make known to those interested that before even the danger had been pointed out, the way to avert it had been found.

L. Gaulard.

London, *14th September*, 1885.

You published last month a communication from Messrs. Zipernowski, Déri and Blathy upon the electtrical transformer constructed by them, and you also called the attention of your readers to a contribution by the Professor Ferraris to the *Lumiére Electrique* of Paris, in which the working of this apparatus is compared to that of our secondary generators; you remark, also, that from this comparison the relative value of the two systems of distribution may be deduced.

In order to prevent any erroneous impressions, we request you to be good enough to give publicity to the following remarks upon the leading points raised, and the conclusions that may be drawn from them.

The Professor Ferraris, in order to establish a comparison between the Zipernowski transformer and the secondary generators, not having at hand a dynamo machine capable of working the two apparatus, was obliged to draw his conclusions from the results previously obtained with the secondary generators and those which resulted from his experiments with the Zipernowski apparatus.

After having determined the resistance of the induced and inducing circuits of the Zipernowski apparatus, the Professor grouped (in imagination) two secondary generators of two H.P. each so as to give to the induced and inducing circuits a resistance equal to that of the Zipernowski apparatus, and draws the conclusion, from the work which the two apparatus would thus furnish upon a secondary circuit having a resistance of 6 ohms, that the weight of copper necessary would be:—

For the Zipernowski apparatus ...	14 kilos.
For the secondary generator ...	36 „

But Professor Ferraris concluded his report to the Academy of Science of Turin with the following sentence, viz.:—

"It may be useful, again, to note that when the core is entirely of iron the best way of employing the secondary generator practically is to work it with a resistance equal to about 26·6 ohms."

It follows that to work our apparatus with a resistance of 6 ohms it was not necessary to couple two apparatus together. By coupling the secondary circuit of a single secondary generator in two parallel circuits, this apparatus would work under the best conditions with a resistance of 6 ohms. If, therefore, we examine what in this case would be the resistances of the primary and secondary circuits of the two apparatus and their corresponding weights of copper, we shall find:—

For the Zipernowski apparatus.

Resistance of primary helix ...	0·562 ohms.
Resistance of secondary helix ...	0·131 „
Total weight of copper ...	14 kilos.

For the Gaulard-Gibbs secondary generator.

Resistance of primary helix ...	0·280 ohms.
Resistance of secondary helix ...	0·070 „
Total weight of copper ...	18 kilos.

It is evident that working under these conditions the secondary generators are, for developing work in an exterior circuit of a given resistance, under much more favourable conditions of interior resistance, P and P^1, than the Zipernowski apparatus, with an unimportant difference in the weight of copper employed.

We need not point out the material difficulties in the construction of the Zipernowski ring, which it would be absolutely impossible to repair in the case of a fault in the primary or secondary circuit, but we would call attention to the concluding paragraph of Prof. Ferraris's remarks, which runs as follows:—

"Consequently in the annular transformer, as well as in that composed of discs, the primary and secondary helices are relatively to the iron under identical conditions."

In the several publications of Messrs. Zipernowski, Déri and Blathy, these gentlemen represent our system as not enabling an independent distribution to each consumer, and, in order to remedy that inconvenience, they propose to place their apparatus in derivation, which certainly enables them to distribute to each consumer the same potential; it is true that they thus adopt the programme of Professor Colombo in his lecture at the Turin exhibition, but we adhere to our opinion that the placing of the apparatus in tension is far preferable, because it enables any consumer to employ glow lamps of any resistance, and arc lamps of any system—in fact, any electrical apparatus, and that without requiring the consumer to trouble himself about his neighbours. The report of M. Tresca to the Academie des Sciences of Paris, on behalf of the jury of the Turin exhibition, established irrefutably that the many transformations required by the numerous types of lamps distributed over the Turin-Lanzo railway at the different stations were carried out with exactness, and Messrs. Zipernowski, Déri and Blathy, have not yet shown a single arc lamp lighted by their system. But whatever they can do or cannot do it has become important to determine accurately what they have the right to do.

When, in 1883, we claimed to have realised the distribution of electrical energy by means of an induction apparatus capable of supplying, at a great number of points on a single circuit, currents of an absolutely variable potential, depending only upon the special construction of each induction apparatus, protestations were raised on all sides in favour of anterior rights, and the ELECTRICAL REVIEW, in its issue of the 21st

April, 1883, reproduced a description originally published in the ELECTRICAL REVIEW of the 15th April, 1879, of the Fuller apparatus in the following terms:—

"It is shown in perspective by fig. 4, and in section by fig. 5. The inventor's aim in the construction of this apparatus was to operate along the main electric circuit a large number of small lights, each being placed in a local circuit, whose currents are induced by the currents of the main circuit. Two magnet cores are arranged parallel with each other, and connected magnetically at the ends as shown in fig. 5. Around the centre of each of these cores is a soft iron head, and at a short distance from each side of this is a head of insulating material. The outer ends of the cores are coiled with insulated copper wire, and so connected together, and to the electric generator, as to produce when in action two consequent opposite magnetic poles at "N" and "S." A, B, C, D and E, represent the connections of these coils. Between the iron heads and these coils are wound smaller coils of insulated wire, the fineness of which depends upon the tension of the current required."

In presence of this information we had to content ourselves with determining the theoretical and practical conditions necessary in an induction apparatus capable of giving a sufficiently economical return to enable the commercial utilisation of this idea, which had been abandoned in consequence of the insufficient results obtained. It was only after much persistent work and considerable sacrifices, both in time and money—in spite of the opposition of all the competent authorities—that with a perseverance to which Prof. Forbes kindly referred in his lecture before the Society of Arts on the 16th February last, we were at last enabled to offer to industry a simple and practical apparatus capable of transforming indefinitely the two factors of the energy of an alternating current with an effective return of 95 per cent.

The question of deciding exactly where the right to the industrial property in an invention commences and finishes is a difficult one and subject to contestation, but in the case before us, thanks to the initiative of the Italian Government in offering a prize for the greatest progress made in the application of electricity to industry, an international jury, formed of the most eminent scientific men whose competency cannot be called in question, took the pains in their report to define with the utmost precision the really novel points in our invention.

The following is an extract from the report of the International Jury of Turin upon the according of the special prize of 15,000 francs offered by the Government and the Municipality of Turin, page 572, sec. 1:—

"The idea of obtaining from a current of small intensity an alternating current of greater force by means of an apparatus upon the same principle as the Ruhmkorff coil, but producing the opposite effect, is so simple and so natural, that it is not difficult to find in the past the same idea several times expressed and subjected to experiment. It finds a practical application in the distribution of energy by electric currents, and above all in electric lighting. Although that idea was as simple as it was natural, and was proposed and even experimented upon by several electricians, Messrs. Gaulard & Gibbs have been the first to make it the object of a special patent. Compared with the ordinary Ruhmkorff coil, the apparatus of Messrs. Gaulard and Gibbs, although based upon the same principle, differs from it essentially in its proportions, the arrangement of its parts and the return obtained, and the experiments made with apparatus differing from the Ruhmkorff bobbin have remained vague projects compared to the practical and effective experiments already made by the company which owns the new patent.

"It is impossible to ignore the fact that never until now has the solution of the problem been presented in a more reasonable and practicable form.

"By reversing the action of an ordinary Ruhmkorff coil and by passing the primary current by the long thin wire, and by gathering the secondary currents in the large short wire it is possible, with a primary current of small intensity, to obtain, by means of a machine of great E.M.F., a secondary current of lower E.M.F., but of much larger intensity—a fact, indeed, which is known and perfectly clear, but it is evident that investigations with such an apparatus would never result in obtaining a coefficient of effective return, and that because of the high resistance—presented by the circuit which serves for the primary current. It is also evident that the apparatus would require too large dimensions and weight, and would be too expensive to return in the form of a secondary current the electrical energy necessary for a practical application.

"Mr. Gaulard has avoided that difficulty in a manner both simple and ingenious, and the merit resides in the means he has devised for transforming the induction coil in such a manner as to arrive at the four following results;

"1. The reduction to their minimum resistance of the primary and secondary circuits.

"2. The obtaining of the maximum of the coefficient of induction of the two circuits for a minimum in the dimensions and weight of the apparatus.

"3. The construction of the apparatus in so simple and easy a manner that the cost price is very little more than the cost of the material employed.

"4. The placing of the primary and secondary circuits in identical positions in respect of the core of iron wire which equalises the E.M.F. produced by the induction of the iron core on the two circuits, primary and secondary, and contributes to a good return, rendering at the same time the apparatus easy of management.

"The International Jury of the Turin Exhibition testified that the apparatus of Messrs. Gaulard and Gibbs was undoubtedly capable of transforming largely the quantity of the energy of which we have previously spoken, and that in reality the apparatus solves simply and easily in many important cases the problem of feeding simultaneously, by means of a single primary current, lamps of different kinds and types, and that, lastly, the intensity of the secondary currents is capable of being easily regulated."

This report clearly and precisely established the different points upon which our invention rests, and thus determines exactly our property, which may be described in the concrete as follows:—*The reduction to their minimum of the resistances in the inducing and induced circuits, and the placing of the inducing and induced circuits in an identical position in regard to the iron core.*

It is only by observing these conditions, which we are the first to have laid down, that Messrs. Zipernowski, Déri and Blathy have been able to construct an apparatus capable of giving a good return by transformation, as, indeed, is admitted by the Professor Ferraris at the conclusion of his remarks upon this apparatus; and, whatever may be the form they adopt for the construction of their transformers, they can never arrive at a practical result without infringing our patents upon one of their capital points.

As regards the employment of a closed magnetic field, which Mr. Blathy, in his letter to the ELECTRICAL REVIEW of the 29th August last, seems to claim as his invention, the description which we have reproduced of the Fuller apparatus (this apparatus must have been known to Mr. Blathy as well as to ourselves, for he refers to it in the pamphlet distributed at the Inventions Exhibition in London), is sufficient to prove to him that on this point he can have no pretention whatever.

It is only just that we should insist upon our rights, which have been so generally recognised and so dearly bought. We object specially to any infringement on the part of Messrs. Zipernowski, Déri and Blathy, because they have acted with a perfect knowledge of the circumstances, and did not commence their experiments until after they had obtained from us at the Turin Exhibition every detail relating to the construction and working of our apparatus.

L. Gaulard, E. Dixon Gibbs.

London, *September 14th*, 1885.

PATERSON & COOPER,
ELECTRIC LIGHT [illegible] ENGINEERS,
ST. PAUL'S WO[illegible] E.C., AND
EUROPEAN [illegible] ROAD, DALSTON.

Prize Medals, International Electrical Exhibitions, Paris, 1881, London, 1882, and Calcutta, 1883.
MANUFACTURERS OF
DYNAMO MACHINES AND LAMPS, AND ALL ACCESSORIES FOR ELECTRIC LIGHT INSTALLATIONS.

DYNAMOS.—PATERSON & COOPER'S Phœnix Dynamos for Incandescent or Arc Lighting; Slowspeed Machines for Ship Lighting; Dynamos for Electro-Deposition of Metals.

SEARCH LIGHTS.—Submarine Arc Lamps for Salvage or Fishing.

ENGINES.—High Pressure and Condensing; Steam Boilers; Turbines, Water Wheels, Overshot Breast and Undershot; Shafting, Pulleys, Plummer Blocks, Gearing, Belting, &c.

ARC LAMPS.—Licensees and Manufacturers of the [illegible] Arc Lamp, the Pilsen Arc Lamp, the "J.F.," and other lamps.

INCANDESCENCE LAMPS.—Agents for Swan, Edison, Bernstein and other incandescence lamps.

MEASURING INSTRUMENTS.—Cardew's Universal Voltmeter, Paterson's Patent Electro-magnet Am and Voltmeters, and Engine-room Ammeters; Ayrton & Perry's Am and Voltmeters, Ohmmeters, Power-meters, Tachometers, &c.

CARBONS.—"WALLACE DIAMOND" Carbons, as used at Severn and Mersey Tunnel Works, Great Western Railway Company, International Health Exhibition, &c.; HARDTMUTH'S SOFT CORE CARBONS.

FITTINGS.—Sockets, Holders, Lamp Reflectors, Brackets, Improved "R.B." and Maynard Switches; Safety Cut-outs, and all requirements for electric light installations; Cables of all descriptions.

TELEGRAPH INSTRUMENTS.—Telephones, Switchboards, Magneto Call Bells, "S.N." Instruments, Railway Signal and Speaking Instruments, Tapper Bells, &c.

EXPLODERS & TORPEDO GEAR.—Admiralty and Mackenzie Firing Keys; Fuse Exploders for Blasting.

Engineering and Electrical Work of all sorts carried out. Estimates and Specifications for Electric Lighting free of cost.

ELECTRIC LIGHT LEADS, GUTTA-PERCHA, INDIA-RUBBER COMPOUND BRAIDED COTTON, SILK-COVERED WIRES.

SPECIAL WIRES FOR DYNAMO MACHINES

PHILLIPS BROS.,
ELECTRICAL WIRE MANUFACTURERS,
THE LEA TELEGRAPH WORKS, HACKNEY WICK,
LONDON,
FORMERLY OF
MACINTOSH LANE, HOMERTON.

ESTABLISHED 1870.

SPECIAL WIRES FOR INCANDESCENT LAMPS

GERMAN SILVER WIRES FOR HIGH RESISTANCES, FLEXIBLE CORDS, TELEPHONE WIRES, &c., &c. MULTIPLE, AERIAL, AND SUBTERRANEAN CABLE WIRES TO ANY SPECIFICATION.

INDIA-RUBBER, GUTTA-PERCHA, & TELEGRAPH
WORKS COMPANY, LIMITED.

Offices and Warehouses: 106 & 100, CANNON STREET, LONDON, E.C.
Works: Silvertown, Essex; Persan-Beaumont, France.

TELEGRAPH ENGINEERS AND MANUFACTURERS
OF

CABLES.—Submarine, Subterranean, and Aerial.

WIRE.—India-Rubber and Gutta-Percha covered in all gauges.

INSTRUMENTS.—"Morse" Tapes, Single Needle, Wheatstone's Alphabetical, Semaphore "Block" Instruments, Bells, Resistance Coils, Sir W. Thomson's, and other Galvanometers, Condensers, Testing Instruments, &c.

BATTERIES.—SOLE MANUFACTURERS FOR GREAT BRITAIN, IRELAND, AND THE COLONIES OF THE CELEBRATED LECLANCHE BATTERY, which has received the most favourable reports from the Postal Telegraph Authorities and other eminent Telegraph Engineers, and is now in general use by the Post Office and English and Continental Railways. As a Battery for all Telegraphic purposes it is undoubtedly pre-eminent. All other kinds of Batteries also manufactured. Ebonite Cells, Carbon Plates, &c.

INSULATORS.—Ebonite, Porcelain, Brownware, &c.

MANUFACTURERS OF THE MOST IMPROVED APPARATUS FOR RAILWAY BLOCK SIGNALLING.

SEMAPHORE REPEATERS, "LIGHT" INDICATORS, AND WALKER'S "PASSENGER AND GUARD" COMMUNICATOR.

TELEGRAPH STORES AND APPARATUS OF EVERY DESCRIPTION.

TORPEDO APPARATUS.

THE INDIA-RUBBER, GUTTA-PERCHA, AND TELEGRAPH WORKS COMPANY (Limited) are Patentees and Manufacturers of a Complete System of Torpedoes for Harbour and Coast Defence,

AND OF THE

SILVERTOWN PATENT FIRING BATTERY.

A Constant Battery for Mining and Blasting Purposes.

CONTRACTS ENTERED INTO for the SUPPLY, CONSTRUCTION, and MAINTENANCE of TELEGRAPH LINES.

MANUFACTURERS OF

VULCANISED INDIA RUBBER.

VALVES, SHEET, BUFFERS, SPRINGS, WASHERS, WHEEL TYRES, CORD TUBING, AND DOOR AND CARRIAGE MATS.

INDIA RUBBER AND CANVAS SUCTION AND DELIVERY HOSE.

INDIA RUBBER and CANVAS STEAM PACKING—ROUND, SQUARE, and SHEET.

INDIA RUBBER MACHINE DRIVING BANDS.

WATERPROOF GARMENTS AND FABRICS:

Coats, Capes, Leggings, Hats, Helmets, Knee Wrappers, Diving Dresses, Sheeting for Hospitals, Water and Air Proof Beds, Pillows, Cushions, Bottles, Baths, Life Belts, Gas Bags.

EBONITE.

Not affected by Vinegar or Hydrochloric or Acetic Acid.

Pumps.
Photographic Articles.

Speaking Tubes, Mouthpieces.
Battery Cells.

Sheet and Rod.
Surgical Appliances.

GUTTA-PERCHA.

Tubing, Belting, Buckets, Bosses for Flax Spinning, &c.

Works: SILVERTOWN, ESSEX, LONDON, E.; PERSAN-BEAUMONT, FRANCE.
London Offices—106, CANNON STREET, E.C.
Warehouse—100, CANNON STREET, E.C.

BRANCHES:

LIVERPOOL	53, Castle Street.	DUBLIN	15, St. Andrew Street.
GLASGOW	20, Dixon Street.	BRISTOL	2, Clare Street.
BRADFORD, YORKSHIRE	85, Kirkgate.	NEWPORT, MON.	82, Dock Street.
SHEFFIELD	64a, High Street.	CARDIFF ...	Pierhead Chambers, Bute Docks.
PORTSMOUTH	49, High Street.	NEWCASTLE-ON-TYNE ...	6, Neville Street.
BELFAST	33, High Street.	NORTH SHIELDS	Borough Road.

BIRMINGHAM ... ... Cobden Buildings, Corporation Street.